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ELECTRICAL CONSTRUCTION AND MAINTENANCE

WITH ELECTRICAL CONTRACTING

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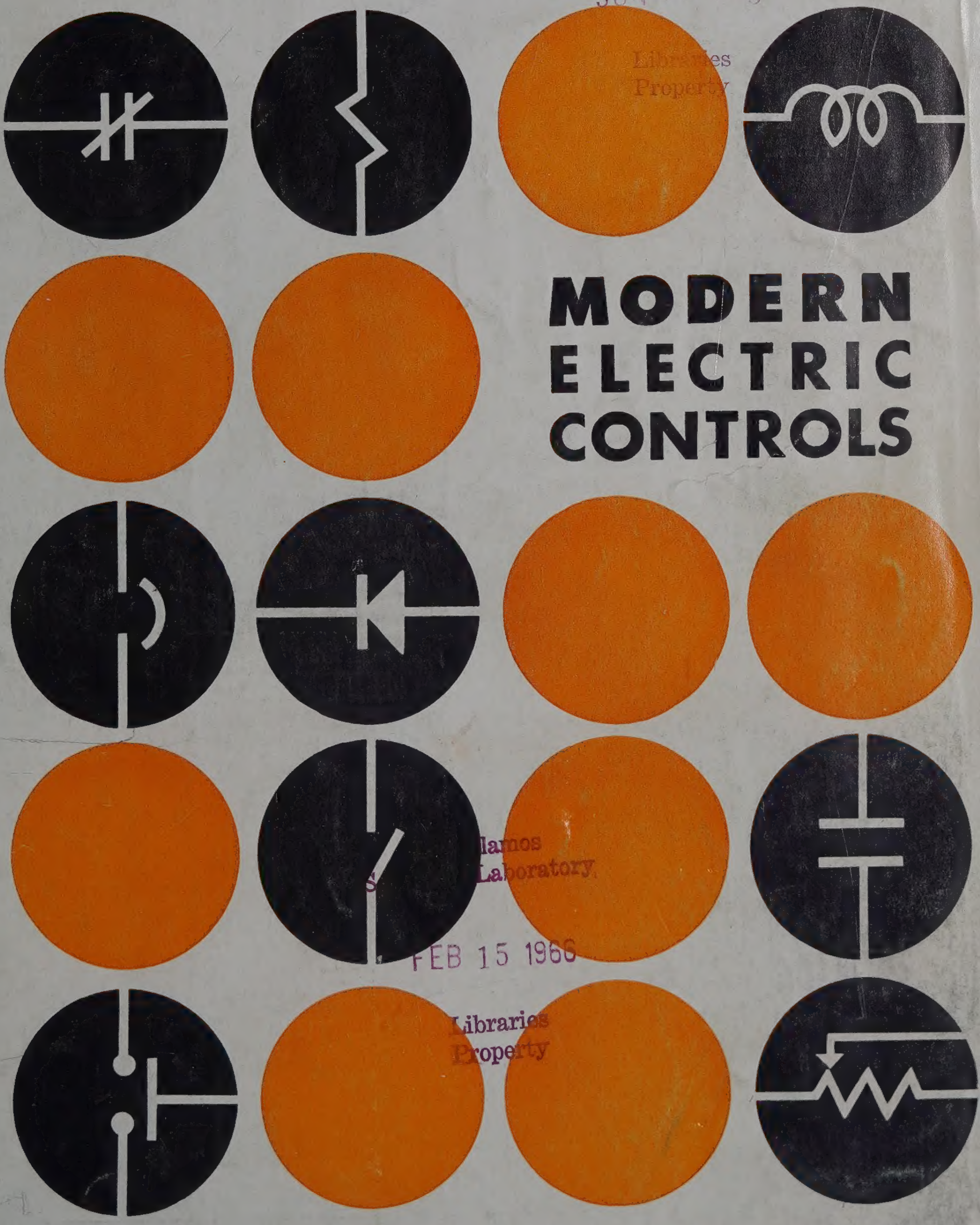
A
SPECIAL
REPORT

OPERATION,
SELECTION
AND
LAYOUT OF
ELECTRICAL
CONTROLS



MODERN ELECTRIC CONTROLS

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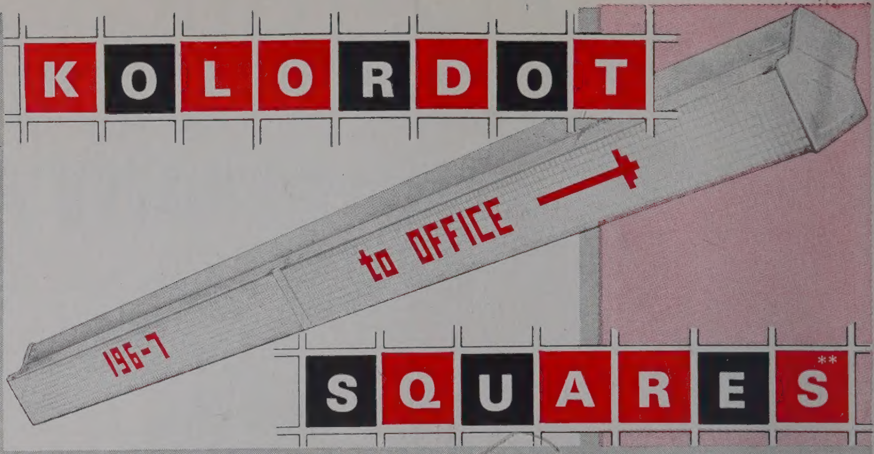
A McGRAW-HILL PUBLICATION | 60TH YEAR

ACCENT
the beauty
*of Gratelite**
with
GUTH
Kolordots

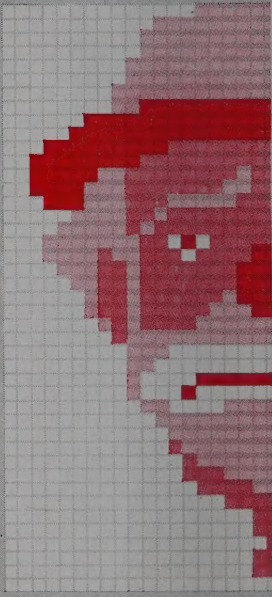


A new dimension of beauty in lighting. Functional and decorative!

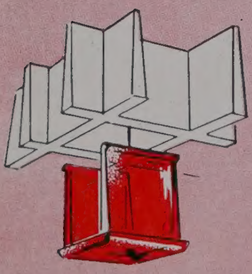
KOLORDOTS . . . versatile as the artist's brush. Just "snap, snap, snap" and you see words and designs or mosaic patterns come to life against the luminous glow of Gratelite . . . in ceilings or fixtures.

Four vivid colors — Sapphire Blue, Cardinal Red, Leaf Green and Vibrant Orange.

How can you use Kolordots? Just let your imagination go (and check the examples we show)!



KOLORDOTS
snap-lock
into the
3/8" Gratelite
cubes



in four vivid colors

Point out departments, designate areas or rooms, or just "play Picasso!" KOLORDOT SQUARES will add new sparkle and beauty to your Gratelite ceiling or fixture.

Guth
LIGHTING
since 1902

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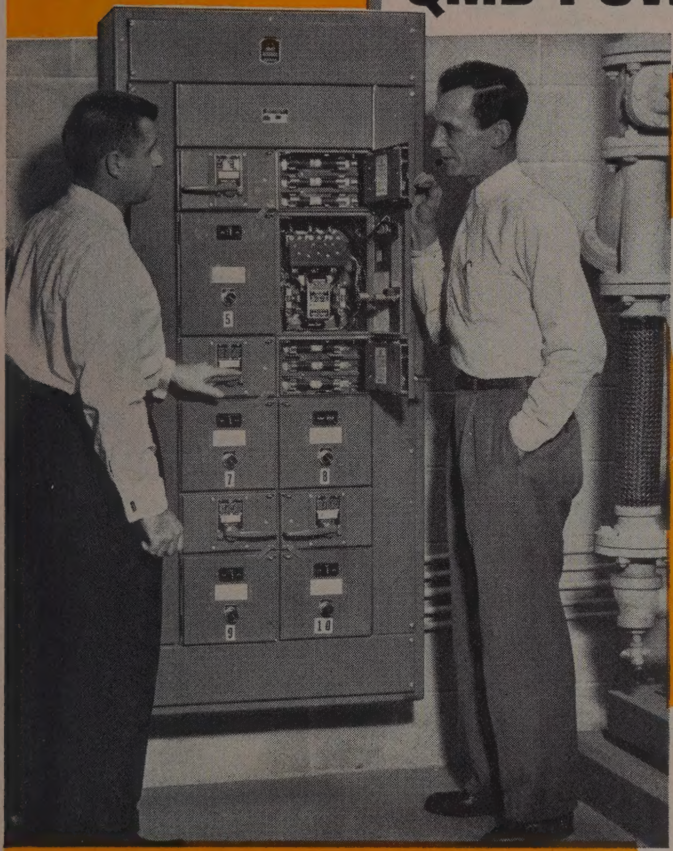
WRITE FOR FULL-COLOR BROCHURE

SPACE–
TIME–
MONEY–

Save All Three with Square D QMB POWER PANELBOARDS



MOTOR STARTERS AND BREAKERS OR SWITCHES COMBINED IN ONE SPACE-SAVING PANELBOARD!

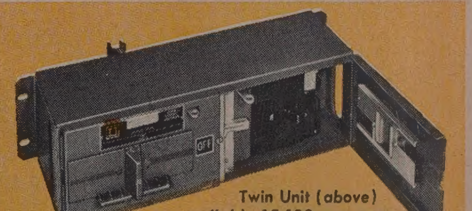
FACTORY-WIRED AND ASSEMBLED OR ENCLOSURES AND COMPONENTS AVAILABLE FROM YOUR SQUARE D DISTRIBUTOR!

BREAKER AND SWITCH UNITS ARE EXCLUSIVE PLUG-IN CONSTRUCTION. INSTALLED OR REARRANGED IN MINUTES!

If the above installation had been made the old way—with trough, and ganging separate switches and starters—it would have taken at least six feet of wall space instead of 30 inches, and four times the installation time.

After this panelboard is installed, Square D's exclusive *PLUG-IN* design permits circuit changes without costly down time. For extra safety, plug-in units are mounted directly above starters, permitting interlocking. No starter or disconnect door can be opened when switch is "ON."

QMB panelboards accommodate reversing or non-reversing starters, sizes 0 through 4; plug-in circuit breakers through 225 amperes; plug-in switches through 200 amperes (bolted through 600 amperes).



Twin Unit (above) available 15-100 amperes
Single Unit available 125-225 amperes

Exclusive Breaker Unit Advantages:
Plug-in construction • Each unit in individual steel enclosure with dead-front construction • Combine switch and breaker units in same panelboard, if desired

Write for the complete story—Square D Company, Mercer Road, Lexington, Kentucky

SQUARE D COMPANY

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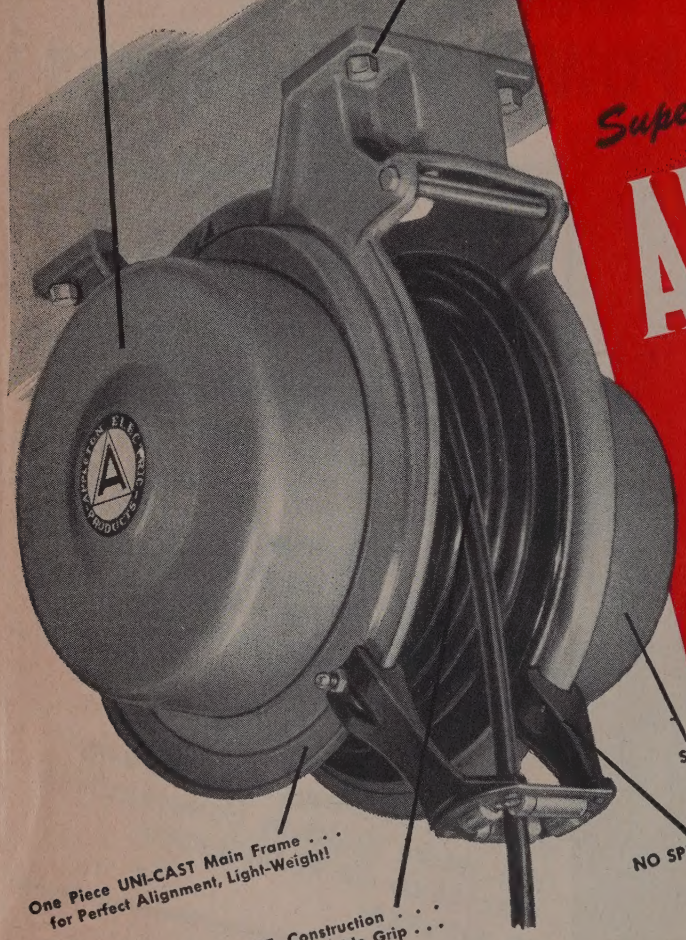
APPLETON®

Automatic Cable Take-Up

REELITES*

Patent Pending



Safety SPRING CARTRIDGE . . . Self Contained . . . Quickly Replaceable!

Engineered for Easy Installation and SAFE MAINTENANCE In All Weather!

Snap-On or Threaded Covers. NO SCREWS Release in Seconds!

NO SPECIAL TOOLS Required for Maintenance . . . Only A Screw Driver!

One Piece UNI-CAST Main Frame . . . for Perfect Alignment, Light-Weight!

HOLLOW SHAFT Construction . . . Pressure-type Internal Cable Grip . . . Fast Cable Replacement!

Newly Designed! Weather-Proof or Explosion-Proof!

A Host of Features that Give You Safe, Uninterrupted Service and Cut Maintenance Costs!

■ There's an APPLETON REELITE built to fit *your* requirements. The ALL NEW RL Series is designed for easy installation, quick, safe servicing and years of trouble-free operation! Your choice of weather-proof or explosion-proof designs. Multiple conductor units available. Newly designed spring motors with finest spring steel for longer life. A safety spring cartridge is self-contained and quickly replaceable for fast servicing when needed.

In addition, with APPLETON you find floating tension brushes for uniform pressure and arc-less contact on newly designed collection rings. Your choice of a wide range of accessories for custom installation, too, *from stock!*

**Only APPLETON Manufactures REELITES!*

Write for Bulletin No. 505

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1701 Wellington Avenue • Chicago 13, Illinois

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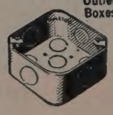
Explosion-Proof Fixtures

Malleable Iron Unilets & Covers

"ST" Series Connectors



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Vol. 60, No. 7 July 1961
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and MAINTENANCE

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ELECTRICAL CONSTRUCTION AND MAINTENANCE

with which is consolidated Electrical Contracting, The Electragist and Electrical Record . . . Established 1901

Published for electrical contractors, electrical departments in industry, engineers, consultants, inspectors and motor shops. Covering engineering, installation, repair, maintenance and management in the field of electrical construction and maintenance.

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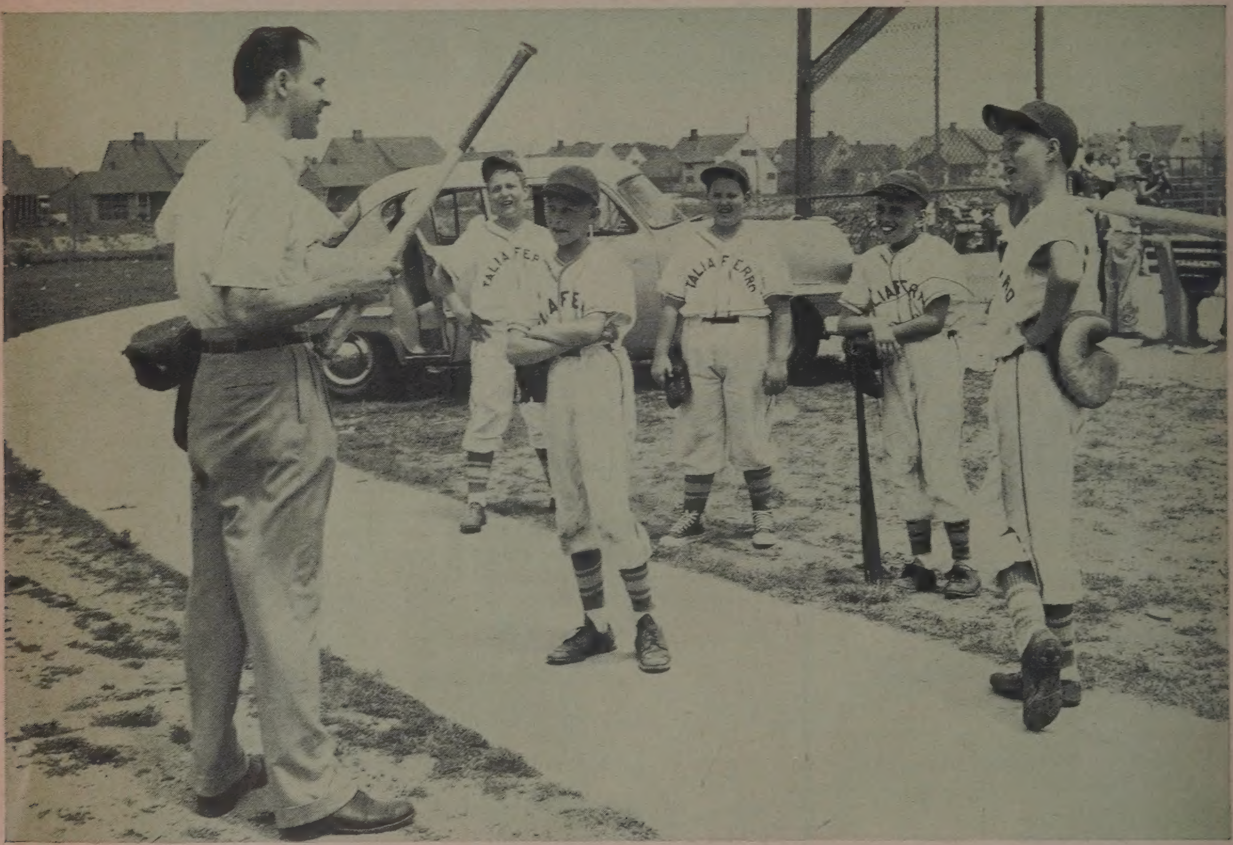
SILICONE NEWS from Dow Corning

Now I'm In Little League



Since We've Converted "Down-time" to "Spare-time" by Specifying Silicones

Three years ago, when Little League baseball was organized in our community, I was interested. Because I'm a family man with three boys, and I'd been a fair ball player, I was asked to manage a team. I wanted to help, but with my job, I knew I wouldn't have the time.

You see, I'm maintenance manager at the local foundry and metal working plant. We have more than 1500 integral horsepower motors. When a motor burns out, it has to be replaced immediately. With the increased frequency of failure in the summer . . . plant temperatures skyrocket . . . my time is not my own.

One day I saw a Dow Corning advertisement about silicone insulated motors. I wrote them and got all the information . . . technical data, too. After studying the material, I suggested to management we run our own life tests by having our problem motors rewound with silicones instead of with Class B insulation, as we were doing.

Result: we now specify silicone insulation in all of our motors exposed to heavy duty cycles, shock loads, frequent start-stop-reverse operation, high ambient temperatures and humidity. Savings are around $5000 a year . . . *not counting the savings in production and maintenance time.*

The sharp reduction in motor maintenance has given me some free time. This summer I managed a Little League team. By the way, my oldest boy looks great at second base, and he's no slouch at the plate.

Say, why don't you write Dow Corning for their literature on silicone insulated motors and transformers? I'm glad I did.

(*This fictional story is based on actual plant experience with silicone insulation. Name provided on request.*)

For information on silicone insulated motors. write Dept. 3619

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

Sidelights

YOUR CONTROL MANUAL

The feature section of this issue is a unique and original manual on electric control, prepared especially for the readers of *Electrical Construction and Maintenance.* Aimed at the everyday needs of electrical contractors, plant electrical people, consulting engineers, electrical inspectors and electric service shops, this manual covers application of control equipment and associated circuits and accessories. Operation of equipment is explained to assure effective selection of devices. Control is analyzed in its elements and in the form of integrated, operating circuits and systems. And, adding great value to all of the engineering data, National Electrical Code rules on all phases of control are fully described and illustrated. This project is planned for continued reference use. Availability of reprints and prices will be announced on this page next month.

MISSILES

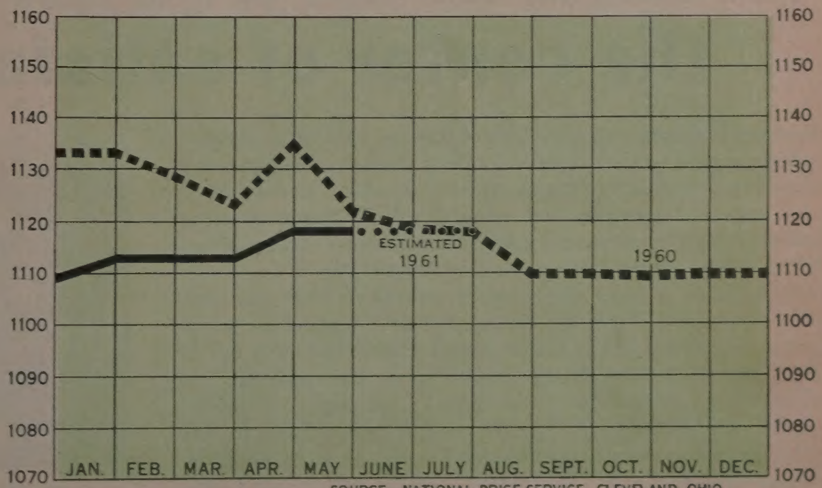
Missiles and missile bases involve a huge complex of electrical systems. On missile launchings at Cape Canaveral, electric power reliability is absolutely essential from the arrival of the "bird" on the pad to the end of the countdown. To bring you a first hand report on the electrical installations, Associate Editor B. C. Cooper spent several days at the Cape interviewing contractors and engineers and personally inspecting the facilities with the cooperation of the Air Force. His story, "Electrical Power Backup Aids Missile Launching," will lead off our feature section in the August issue.

LOW-VOLTAGE STANDARD

Tentative UL standards for low-voltage swimming pool lighting transformers set the maximum open circuit secondary voltage at 15 volts. Lamps are rated at 12.8 volts. The contractor is faced with the practically impossible problem of designing a wiring system involving substantial circuit lengths and heavy currents with a voltage drop of only 2.2 volts including the transformer losses. It seems that some more realistic coordination could be achieved without significantly impairing the inherent safety of low-voltage lighting. The 15-volt maximum may be a good safe value but if it compels reduced lighting performance or impractically large and costly conductors, it defeats its own purpose.

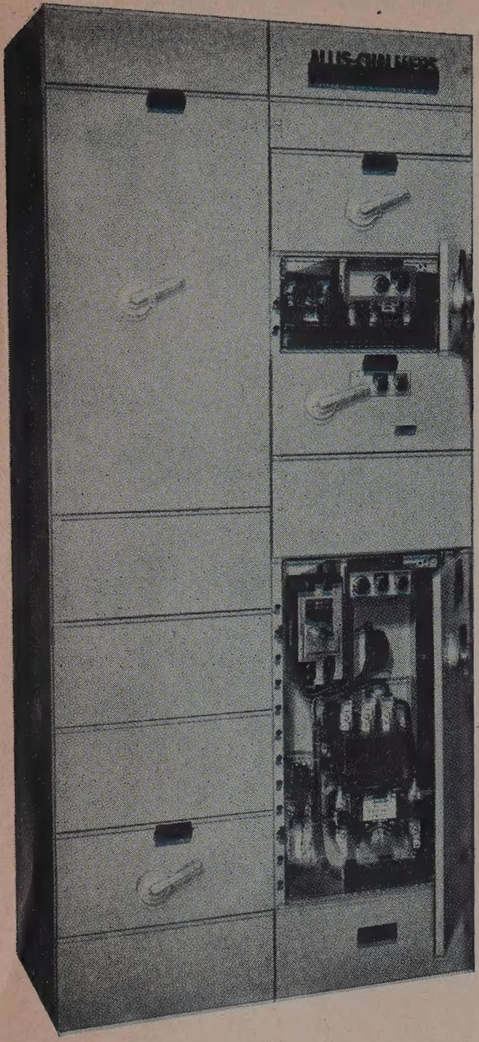
ELECTRICAL MATERIALS COST INDEX

BASE LINE (1000) REPRESENTS COSTS OF TYPICAL ASSORTMENT OF MATERIALS FOR A SELECTED JOB AS OF NOVEMBER 1, 1951. INDEX POINTS REPRESENT THE VARIATION OF THESE SAME MATERIAL COSTS AS OF THE FIRST OF EACH MONTH.



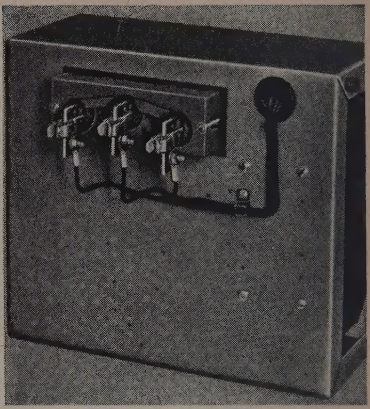
SOURCE - NATIONAL PRICE SERVICE, CLEVELAND, OHIO

ALLIS-CHALMERS

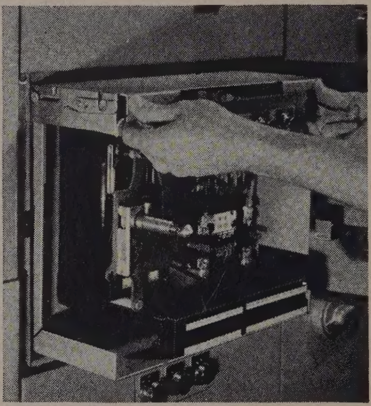


1. Centralized control saves space, cuts installation and engineering costs.

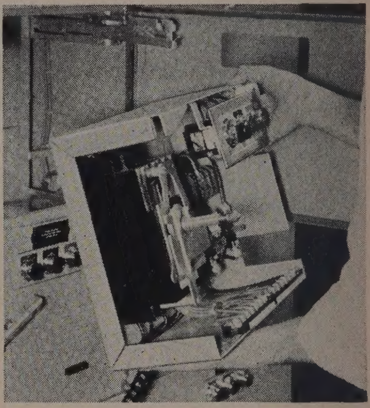
2. Exclusive plug-in terminal blocks permit removal of units without tools. Fully accessible location at front of units simplifies your wiring.



3. Extra heavy plug-in stabs and positive alignment provided by TRACK-GUIDE drawout mechanism assure trouble-free electrical connection.



4. With TRACK-GUIDE mechanism, units can be easily and safely de-energized and locked out, or withdrawn from enclosure for inspection and maintenance.



5. Units can be tilted up for inspection of stabs without removing from TRACK-GUIDE mechanism, or fully removed for bench maintenance or interchange.

...six reasons why Allis-Chalmers new motor control center design is

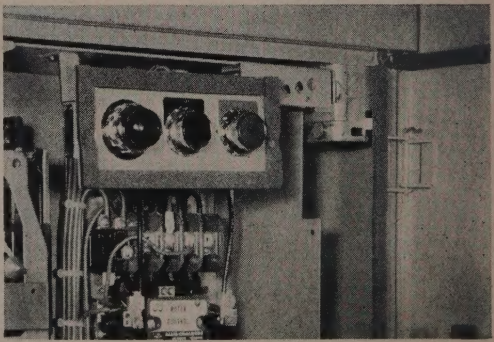
the center of satisfaction

Satisfaction? It comes with every one of the new (yet fully proven) low-voltage control centers from A-C. Their clean lean design saves valuable space. Exclusive plug-in terminal blocks cut installation time . . . speed inspection and removal. *Track-Guide* drawout mechanism lowers maintenance costs. Control units can be drawn out, tilted up, or completely removed without tools.

Safety features of these new control centers provide *sure* protection to personnel. Units can be quickly de-energized for maintenance or inspection work. Units cannot accidentally fall out of *Track-Guide* mechanism during inspection or maintenance.

Reliability . . . versatility . . . economy . . . strength . . . safety. You name the feature — A-C motor control centers have it. *Ask your A-C representative or distributor for all the facts. Or write* **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wis.*

Track-Guide is an Allis-Chalmers trademark. A-1486



6. Mounting of pilot lights and pushbuttons on the removable control units eliminates failures common with hinged wiring.

Washington Report

JULY • 1961

The second half of 1961 will show continued improvement in business and economic growth, according to both government and private economists. Treasury Secretary Dillon recently predicted an economic boom a year from now, with Gross National Product (GNP) hitting an annual rate of $555 billion next year. Even eliminating the increased Federal spending, which is also included in GNP figures and helps to distort GNP statistics as a true measure of economic growth, the outlook for improved business is good.

Construction expenditures, an economic mainstay throughout the postwar years, are showing renewed strength. Personal income set a new record in May, with a seasonally-adjusted annual rate of $413.7 billion. Industrial output hit a nine-month high in May of 108% of the 1957 average, up from the 1st quarter 1961 level of 102%. Employment at mid-May was 66,778,000, or 93.5% of the total civilian labor force of 71.5 million. Electric power output last month was running above 15 billion kwhr weekly, or about 6% ahead of the year-earlier rate. Also, steel production was running above two million tons weekly last month, and auto production for the year was being estimated at 5½ to 6 million cars, or nearly a half million more than had been estimated previously.

New construction expenditures in May rose to a seasonally-adjusted annual rate of $56.7 billion, up from a $55.3 billion rate in April. This was the third consecutive monthly increase, to the highest rate since mid-1959.

Value of new construction put in place in May was $4.8 billion, up 11% from the April total, and 3% above the May 1960 total. Spending for private construction in May was $3.3 billion, up 2% from the April level, and 1% higher than for May 1961. Public construction in May totaled $1.5 billion, up 5% from April, and 7% ahead of May 1960.

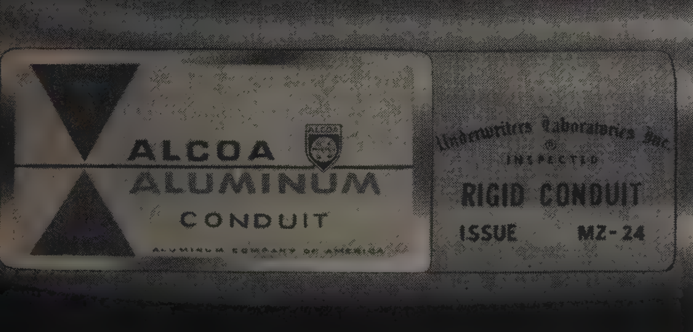
Capital outlays for new plant and equipment will rise during this third quarter of 1961, according to quarterly survey of business by Commerce Dept.-Securities Exchange Commission. But projected capital spending for 1961 will total only $34.5 billion, Commerce-SEC survey indicates, which is about 3% less than for 1960.

Housing starts in May topped April by 8% on a seasonally-adjusted basis, or 11% on actual number of homes started, which was 124,000 units. Starts for the first five months of 1961 were at an average annual rate of about 1,220,000 units. Government and private analysts expect an upswing in this second half of the year, and their earlier forecast of 1,300,000 units for the year to be achieved. Residential work put in place in May was at $21.7 billion annual rate, an improvement over the previous eight months, but still far short of the $25-billion rate of May 1959.

Demand for housing is still lagging, as there is no longer a general housing shortage, notwithstanding the Administration's efforts to spur homebuilding with lower interest rates, no down payments, and 40-year mortgages.

Congress extended corporate income taxes at 52% for another 12 months, for the ninth time since the levy was first passed as a "temporary" Korean war measure in 1951. Also extended was the 10% excise tax rates on autos, general telephone service and passenger travel tickets; and existing levies on liquor and cigarettes.

ON THE NOSE!



...just one of the reasons why Alcoa aluminum electrical rigid conduit is so easy to install

No spring-back in aluminum conduit means bends " the nose" every time.

For small sizes, use a hickey or an EMT bender (size larger). Regardless of size, mechanical and hydrau benders make one-shot, uniform bends with a minim of time and effort.

What else is there to look for in conduit?

Weight Alcoa aluminum conduit weighs only one-th as much as steel conduit. From warehouse to erect site there is only one-third as much weight to lift, lo carry and erect.

Cutting and threading With hacksaw on small si and power on large, cutting is quick and easy. Use sh dies and regular cutting oils, and get clean, well-form threads every time.

Wirepulling Wire aluminum conduit quickly, easil using a plastic "rigid" rope fish tape, a flexible rou steel tape, or a pressure-operated gun and plastic pull rope. Alcoa conduit is factory lubricated for easy pulli

Don't forget, too, that Alcoa aluminum conduit ma a good investment for your *customers*. It's corrosi resistant, nontoxic, nonmagnetic, nonstaining, neat appearance, with a seemingly endless service life.

Get all the facts and figures for your next job. Ad tional information and help are available from your ne by Alcoa-Rome representative. Or write to Dept. 7- Rome Cable Division of Alcoa, Rome, New York, free technical literature.

EASY TO BEND. Alcoa aluminum conduit can be bent quickly, eas Use EMT benders or hickeys with sizes to 1¼ inch. Standard po benders (below) can be used on all sizes.

ALCOA
ROME CABLE
DIVISION

Announcing 2 New RIDGID® CONDUIT BENDERS

EXTRA-DEEP SOCKETS MINIMIZE HANDLE BREAKAGE!

Cast of high-strength malleable, these new RIDGID Conduit Benders have an exceptionally smooth, typically RIDGID quality finish you'll like on sight. Look in the extra deep sockets, and you'll see the threads down at the bottom. Elimination of strain on threads of pipe handle reduces breakage.

RIDGID Thin-Wall Conduit Benders Available in 3 Sizes

B-1677	**Bends ½″ Thin-Wall Conduit to 4″ Inside Radius**
B-1678	**Bends ¾″ Thin-Wall and ½″ Heavy-Wall Conduit to 5″ Inside Radius**
B-1679	**Bends 1″ Thin-Wall and ¾″ Heavy-Wall Conduit to 6½″ Inside Radius**

Exceptionally smooth side-walls hug conduit snugly . . . minimize distortion. Benders form conduit to meet National Electric Code Standards. Steadying foot pressure is easily applied on non-slip step plate. Easy-to-see arrows give accurate guide for back-to-back and stub bends.

RIDGID Hickey-Type, Heavy-Wall Conduit Benders

B-1711 Bends ½″ and ¾″ Heavy-Wall Conduit
B-1712 Bends ¾″, 1″ and 1¼″ Heavy-Wall Conduit

Here's a rugged bender for heavy-wall conduit. Deep notch in lifting hook protects threaded ends. Face of bender has hardened teeth for safe, long wearing, non-slip grip.

Call your Distributor today. For your convenience, he maintains a complete stock of RIDGID Work-Saver Pipe Tools and parts!

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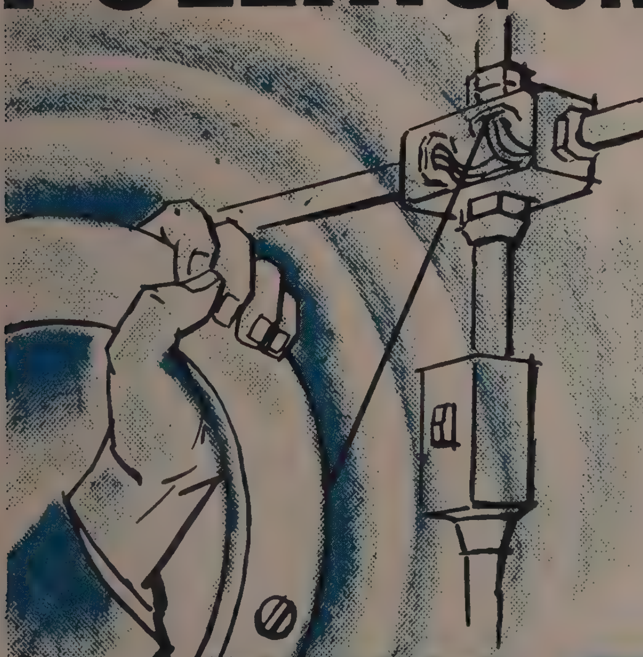
THE RIDGE TOOL COMPANY, ELYRIA, OHIO, U.S.A.

PULLING OR PUSHING



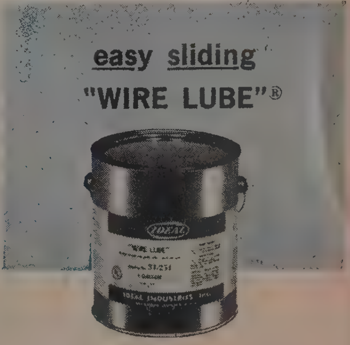
This combination has proved simplest and best in the field for

ALL WIRE PULLING JOBS

Why guess? Thousands of contractors have *proved* there's no substitute for high-tensile, spring *steel* in a fish tape. It won't break, fray or weaken—needs no special guides. With the Ideal spring-wound leader it feeds into outlet boxes and through difficult runs fast, smooth and easy. Then, Ideal "Wire-Lube" *slides* the cable through the conduit with least strain and effort. Contractors find there's nothing to equal this money-saving combination. You will, too!

Oil tempered, high-tensile strength flat spring steel tape. Reel provides a high-leverage puller-pusher, protects hands, serves as a container. Tape can't spring loose. Completely safe on all jobs—no flying parts. No special instruction or supervision needed. Lengths 50 to 200 feet. Priced so low many contractors consider it a **throw-away** on the job!

Music wire spring wound around a 20" airplane type cable slips into outlet boxes and around 90° bends like an eel. Hooks onto Ideal Fish Tape instantly. Takes up to 6 No. 10 bare wires. Tested for 400 lb. pull.



The pulling compound that takes the fight out of rubber, lead or plastic covered wire or cable as they are pulled into conduit and around bends and tight spots. Easily applied by hand or brush. Guards insulation against breaks, scrapes and strains. Dries to a fine lubricating powder that makes it easy to add or remove wires later. Non-corrosive, non-combustible, harmless to hands or clothes. For use in steel, aluminum or fiber conduit. Not for use with asbestos covered wire.

If you aren't using this Ideal wire-pulling combination, better tell your Ideal Distributor you want to. Or mail coupon for free catalog data.

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Company____________ Title____________

Address____________________

City__________ Zone_____ State__________

Owner: **DORIC CO.,** Seattle, Wash.
Architect: **DOUGLAS A. BACON,** Bellevue, Wash.
Electrical Contractor:
LAKESIDE ELECTRIC CO.
Bellevue, Wash.

Electrical Protection goes MODERN *with* BUSS Fuses...

at the Doric 6th. Avenue Motor Hotel, Seattle, Wash.

Travelers staying at this new, luxurious 175 unit motor hotel enjoy the latest conveniences of electrical living. Even the rooms are heated electrically so each person may select the room temperature he prefers.

These modern services require large electrical capacity. As a result, the available fault current is approximately 70,000 amperes.

Safe protection against faults of this magnitude is assured by the BUSS Hi-Cap fuses installed in the main entrance service. These fuses have an interrupting rating of 200,000 amperes rms. symmetrical.

To maintain safe, modern protection throughout the electrical system,—and to safeguard against unnecessary interruptions in electrical service, FUSETRON dual-element fuses are installed in the branch circuit switches.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION

Mr. S. Andrew Sharpe, Manager of Lakeside Electric Co., at main switchboard of Doric Motor Hotel.

Mains and feeders protected with BUSS Hi-Cap fuses. Branch circuits protected by FUSETRON dual-element fuses.

There is a safe, modern BUSS or FUSETRON fuse with specific characteristics to match your requirements.

Available from BUSS: High interrupting capacity fuses to protect against fault currents up to 200,000 amperes; current-limiting fuses to restrict let-thru fault currents to safe values; long time-lag (dual-element) fuses to prevent needless outages on harmless overloads.

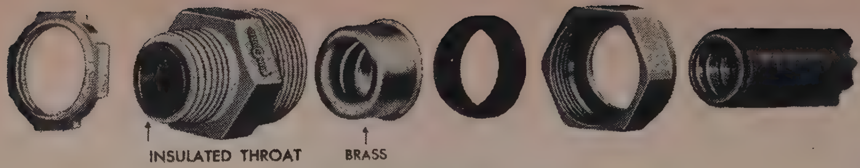
And with Fuses safe protection remains safe. BUSS and FUSETRON fuses are just as safe and accurate 20 years or longer after installation as on the day installed. Dust, fumes, corrosion or age cannot prevent them from opening when they should.

For more information on

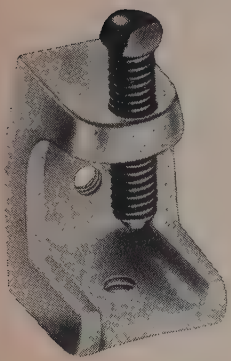
FUSETRON dual-element fuses
(loads of 0 to 600 amps) .... **write for bulletin FIS**

BUSS Hi-Cap fuses
(loads above 600 amps.) .... **write for bulletin HCS**

BUSSMANN MFG. DIVISION, McGraw-Edison Co. **ST. LOUIS 7, MO.**



Malleable Iron Liquid-Tite Connectors



M.I. Beam Clamps

M.I. 90° Corner Adapters
and Corner Elbows

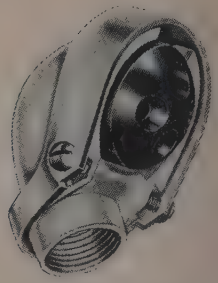
QUALITY MALLEABLE IRON FITTINGS ARE AVAILABLE!

GEDNEY'S

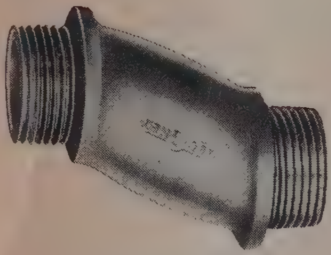
Complete Line is Precision-Made of Unbreakable Malleable Iron . . .

- *Unmatched for Toughness*
- *Impervious to Corrosion*

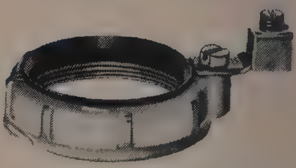
GEDNEY FITTINGS FIT



M.I. Entrance Caps



M.I. Offset Connectors
and Offset Nipples



M.I. Insulated Bushings

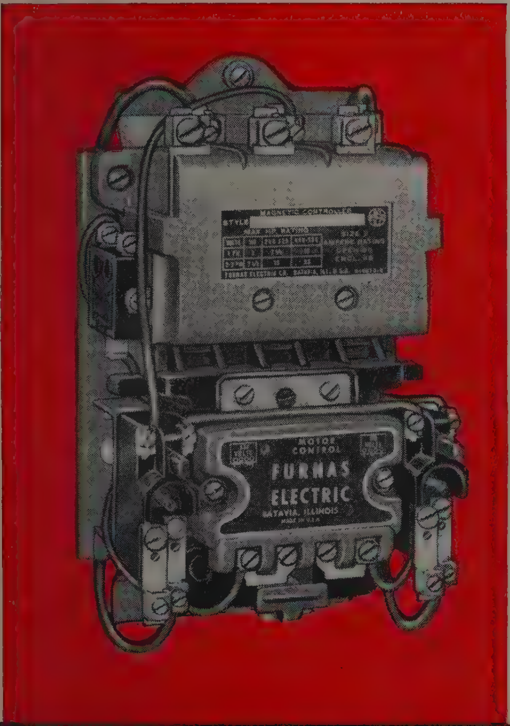
GEDNEY
ELECTRIC COMPANY, INC.
GEDNEY
AMERICAS BLDG. • RADIO CITY • NEW YORK 20
Foundry, Factory and Shipping Point: Terryville, Conn.

M.I. Conduit Bodies

M.I. Armored Cable
& Non Metallic Connectors

M.I. 3 Piece Conduit Couplings

DON'T WASTE MONEY ON "USELESS" STARTER CAPACITY



Match the right starter to the motor capacity by taking advantage of exclusive Furnas "in-between" starter sizes. 10 sizes instead of the usual 6 allow you to use the *right* control at the *right* price. You don't waste money, space or capacity and you do the job right!

- **Dual Voltage magnet coils, 110-220 or 220-440 volts, are reconnectable on the job.**
- **Standardized design and interchangeability of parts mean quick and easy field modification.**
- **All sub-assemblies are front removable for easy servicing, inspection or replacement.**
- **Modern enclosures are compactly designed, yet have ample room for easy wiring.**
- **Trip-free thermal overload relays—third overload can be easily added in the field.**

FORWARD WITH FURNAS FIRSTS—
Pacesetters of the Industry!

In addition to providing better controls, the many Furnas Firsts in control development have proved advantageous to the contractor by making installation simpler, and field modification quicker and easier. Among these Furnas Firsts are "in-between" starter sizes, dual voltage coils, motor mount starters, switchlets for auxiliary contacts, pressure operated starters and many others.

Write Today! **See for yourself how Furnas Electric Controls set the pace for the industry. Ask for Bulletin 5900, 1067 McKee Street, Batavia, Illinois.**

A105

FURNAS

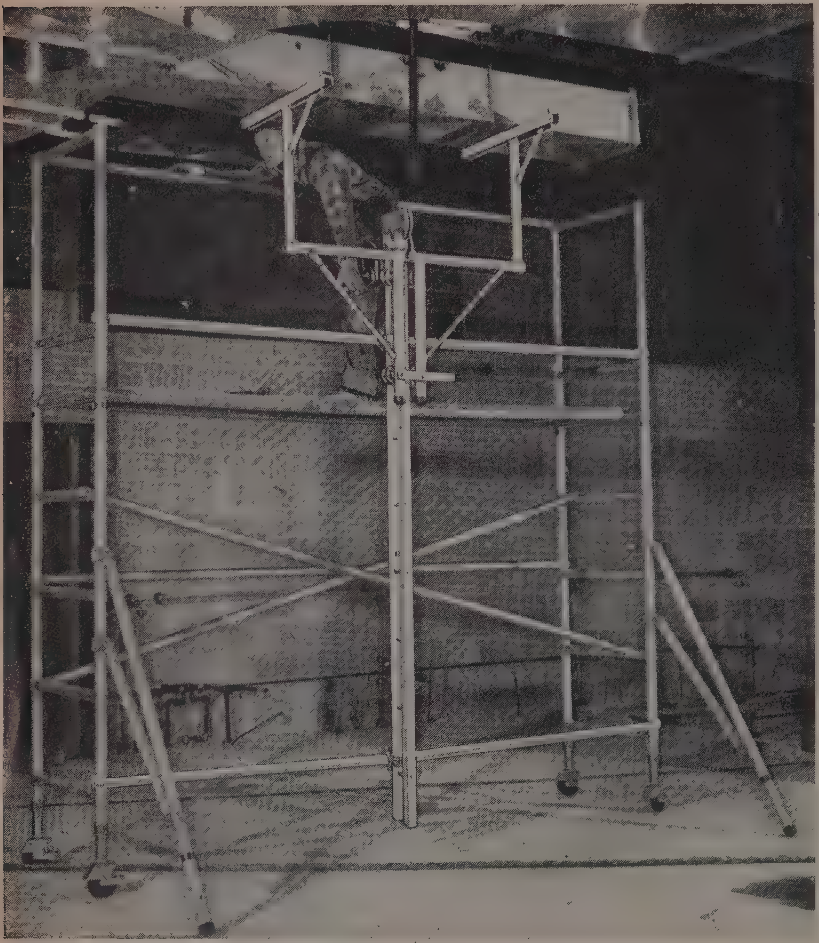
FURNAS ELECTRIC COMPANY

BATAVIA, ILLINOIS

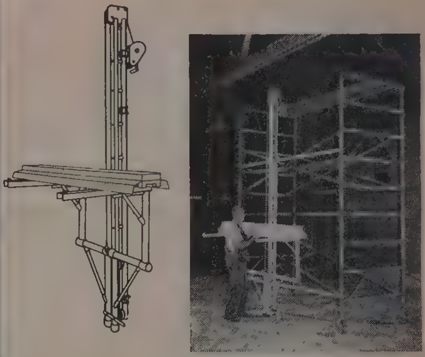
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

Double your workman's production...

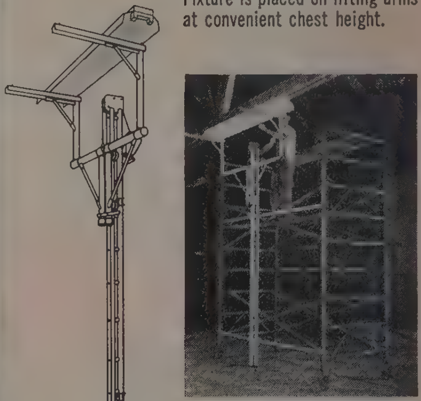
UP-RIGHT mechanical man lifts & positions material for fast, one-man installation



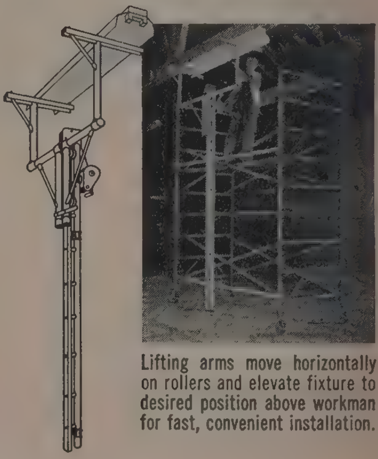
Workman and mechanical man accurately position 9 ft. long air duct for easy, rapid installation.



Fixture is placed on lifting arms at convenient chest height.



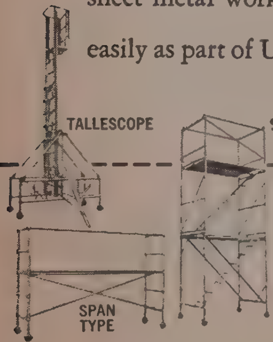
Fixture is elevated along vertical track by winch.



Lifting arms move horizontally on rollers and elevate fixture to desired position above workman for fast, convenient installation.

Mechanical man is an aluminum hoist assembly instantly attachable to any Up-Right or other scaffold. It saves fatigue and manhours in positioning fluorescent fixtures, bus-ducts, conduit, pipe and sheet metal work for overhead installation at any height. Rolled easily as part of Up-Right aluminum scaffold.

Write for descriptive circular



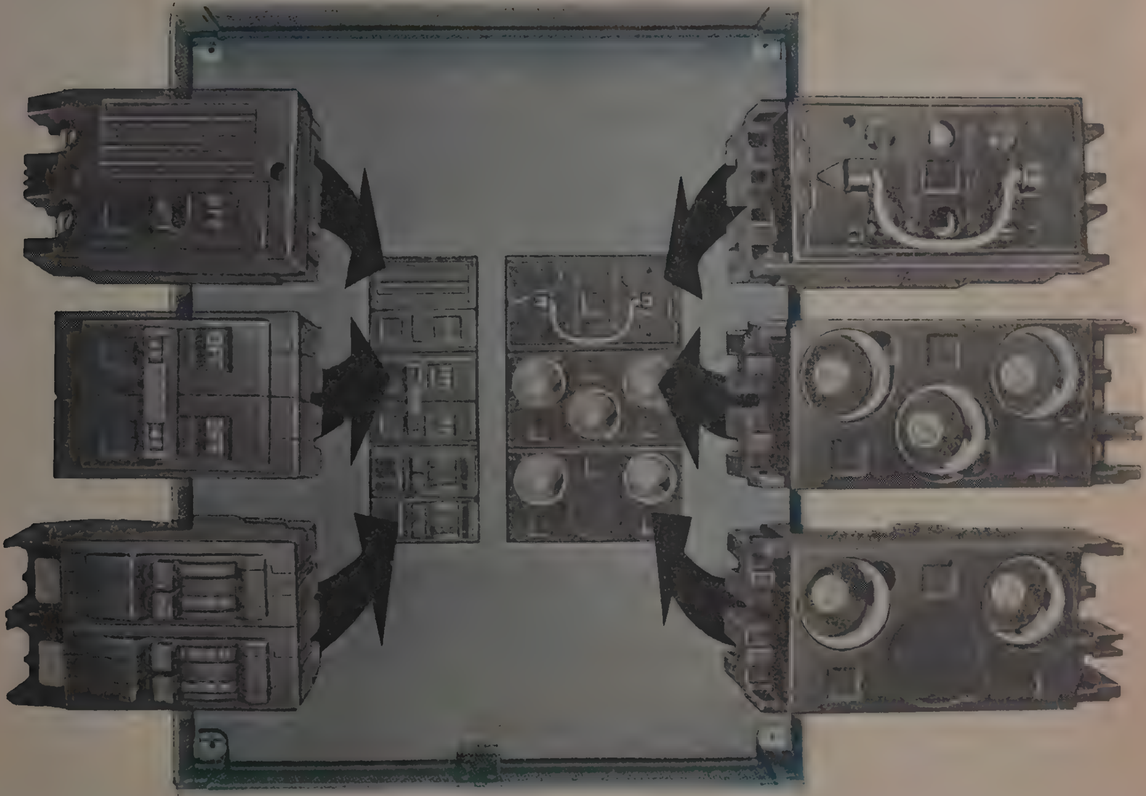
UP-RIGHT SCAFFOLDS

DEPT. 177 1013 PARDEE, BERKELEY, CALIFORNIA

In Canada: Up-Right Scaffolds Ltd., 120 Russet Ave., Oshawa, Ontario

NEW BREAKER/FUSE PANEL

Plug in breakers and fuses,
mount surface or flush
all with one basic box

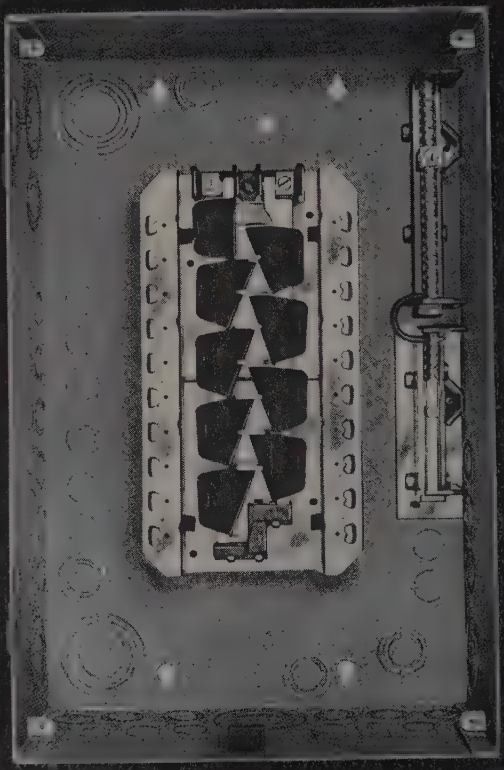


Now General Electric gives you the widest choice in service entrance equipment: "TWIN*" circuit breaker load centers... fuse puller panels and the new 4-in-1* Breaker/Fuse Panels.

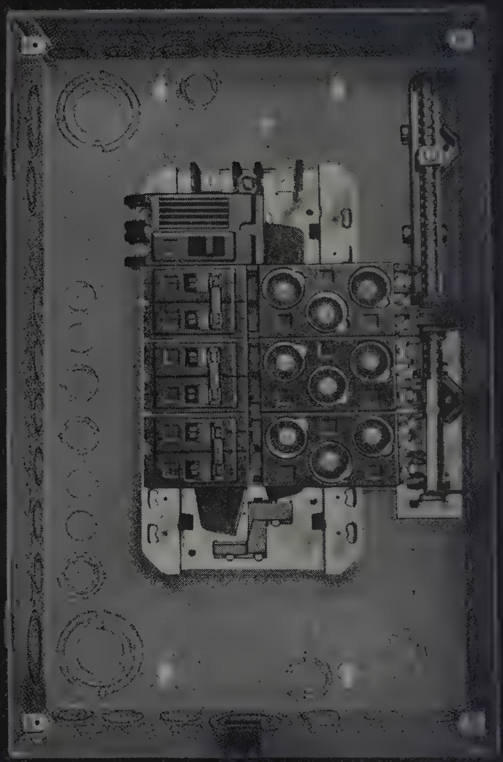
*Trade Mark of General Electric Company.

GENERAL ELECTRIC

SELECT ONE PANEL: PLUG IN



Typical Breaker/Fuse Panel . . . Cat. No. TP1612, shipped complete with box, front, interior; accepts both breakers and new G-E plug-in Fuse Blocks. Shown at right are three ways to assemble this panel.



Mix Breakers and Fuses . . . Cat. No. TP1612 with back-fed 100-amp main breaker, three 2-pole TQL breakers, plus nine plug fuses—all in the same box. Only new G-E Breaker/Fuse Panels offer versatility like this!

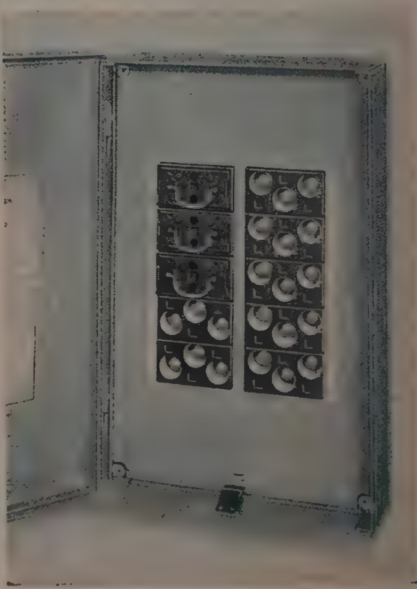
COMBINATION ENCLOSURES - MOUNT EITHER SURFACE OR FLUSH

New Flush Frame Locks Around Box, Hides Rough Plaster, Assures Neat Job.

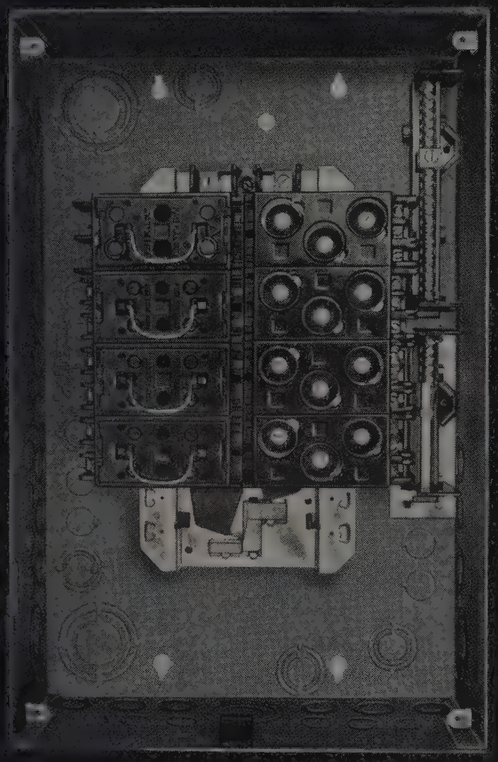
Here's dual mounting versatility: For flush installations, frame locks tight around box. Stud mounting ears automatically position box for ½-inch drywall — save time and labor . . . Nails quickly to studs.

For surface jobs, simply discard flush frame. It's as simple as that!

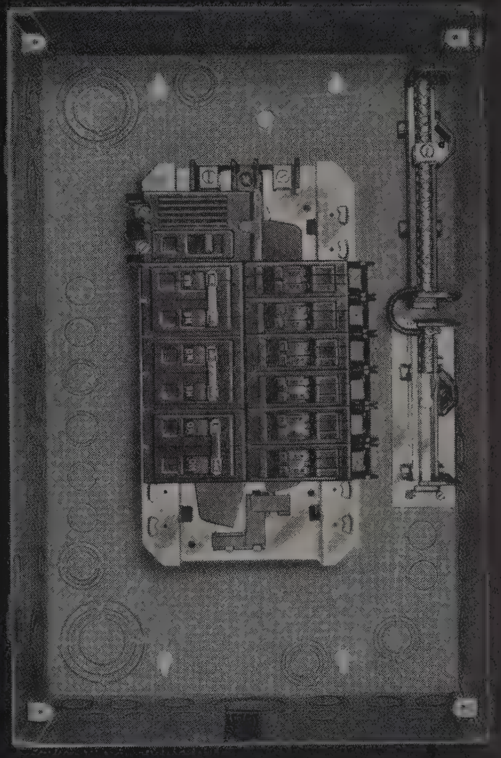
Complete Line 100, 125, 150, 200 amperes, 12 to 40 circuits. Main-lugs-only, split bus and main disconnect models cover full range of applications.



BREAKERS, FUSES...OR BOTH!



All Fusible . . . In the same TP1612 panel another choice is one 60-amp, three 30-amp pullers, plus 12 plug fuses. You plug in new G-E fuse blocks just like breakers — this is only one of many combinations possible.



All Breakers . . . Another way to wire the TP1612: plug in 100-amp breaker (connect line wires to breaker load terminals for backfed main), plus three 2-pole TQL's and 6 "TWIN" breakers, providing 12 lighting circuits.

A BOLD NEW APPROACH TO VERSATILITY...

Basic 4-in-1 Idea: With a single catalog number you order a combination flush-surface panel which accepts plug-in breakers, fuse blocks or both!

Wide Choice of Plug-in Units: Breaker/Fuse Panels accept any combination of these plug-in units . . .

- 30- and 60-amp fuse pullers (horsepower rated)
- 2- and 3-circuit plug fuse blocks
- 2-pole circuit breakers, 10 to 100 amperes
- Single-pole TQL and "TWIN" circuit breakers

Bonus Installation Time-Savers: Snap-out front shield; stud mounting ears; reversible box and front; spring-mounted, snap-out interior; removable door; full sequence phasing. All panels are U/L listed and meet NEC non-interchangeability requirements. Available now from your General Electric distributor. Circuit Protective Devices Dept., General Electric Co., Plainville, Conn.

GENERAL ELECTRIC

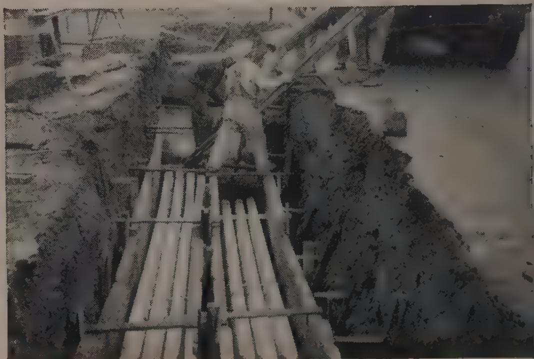
Save on installed costs with Transite Electrical Ducts

To meet today's strict conduit specifications and, at the same time, keep installed costs down, more and more contractors are turning to Transite® Ducts.

Transite's long lengths and light weight reduce handling and laying costs. This, combined with a quick coupling method, permits rapid assembly. A small but complete line of fittings simplifies the assembly of duct-bank configurations even with complex constructions. Finally, the smooth inner walls of Transite make cable pulling easier—reduce strain on both the cable and pulling equipment as well as the duct. Result? Fast installation and a saving on every foot of duct you lay!

Non-combustible, non-sparking Transite resists corrosive soils, electrolytic action and stress of normal soil movement. Its tight joints are flexible yet permanent. They lock out water-borne silt, roots and other system disrupters.

For full details, write Johns-Manville, Box 14, ECM-7, New York 16, N. Y. In Canada: Port Credit, Ont. Cable: Johnmanvil.



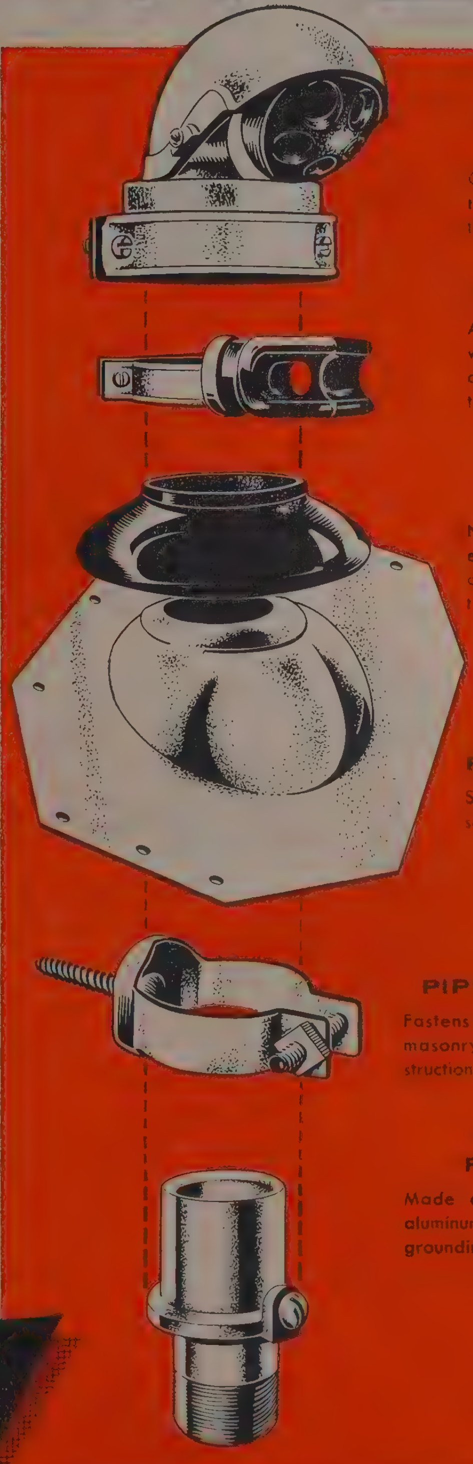
JOHNS-MANVILLE

Cut Costs On Low Roof Construction With
WEAVER
SERVICE ENTRANCE MAST KITS

Six Standard Kits Cover Most Installations

These Weaver Mast Kits provide everything needed for low roof service entrance installation except the conduit. All parts are designed for easy installation without tools. Six standard kits cover most installations or, on request, Weaver will pack special kits. Individual items may, of course, be ordered to meet local requirements.

Ask your Electrical Wholesaler for WEAVER Mast Kits



DUAL-GRIP HEAD

Clamps on pipe with two screws . . . no threading necessary.

INSULATOR

All porcelain insulator with exclusive snap-on action cuts installation time.

STORM COLLAR

Neoprene storm collar eliminates caulking . . . assures lifetime protection against leaks.

FLASH PLATE

Supports mast and serves as flashing.

PIPE SUPPORT

Fastens conduit securely to masonry . . . one piece construction.

OFFSET REDUCER

Made of high-strength cast aluminum . . . assures positive grounding.

J. A. WEAVER Company

2110 Howard Street • St. Louis 6, Mo. • GArfield 1-6336

Type A LAWN-GLO Luminaire

Type B LAWN-GLO Luminaire

Type C LAWN-GLO Luminaire

L-M's exclusive "Lawn-Glo"(TM) luminaires are available in three styles, as shown above. Lawn-Glo luminaires offer hundreds of possible applications. Styled specially for locations where soft, low-level lighting is desired, in a high quality unit. Engineered reflector directs the light downward, does not waste it in glare. Most desirable for home driveways and patios; for smaller parks, playgrounds, swimming pools; for motels, gardens, terraces. Completely weatherproof design. Socket easily removed for lamp replacement. Concealed convenience outlet in base. Uses standard household incandescent lamps up to 150 watts. Choice of six decorator colors and brushed aluminum. Optional with redwood or black metal pole. Sold only through Authorized L-M Distributors.

L-M's Outdoor Lighting Line Offer

Units are excellent quality construction, engineered for efficiency and ease of applicati

Line Material, long a leader in quality outdoor lighting, offers modern, highly styled units to meet all outdoor lighting needs—industrial, commercial and residential.

Under a new distributor policy, L-M outdoor lighting equipment is available through electrical wholesalers—Authorized L-M Distributors. These distributors are reputable, competent firms who have been carefully selected by Line Material to assure you of service information and delivery.

Lighting for Every Outdoor Application

Line Material styled equipment is widely used in shopping centers, motels, hotels, swimming pools, trailer parks, parking lots, country clubs, public and private parks, fair grounds, amusement parks, churches, hospitals, marinas and yacht clubs, restaurants and drive-ins; and many other industrial and commercial locations where good lighting builds traffic, facilitates operations, and increases security.

Thousands of L-M lighting units have been installed at motels, parks, drive-in restaurants, and many industrial and residential locations.

OUR 50TH YEAR
1911 — 1961

LINE MATERIAL®

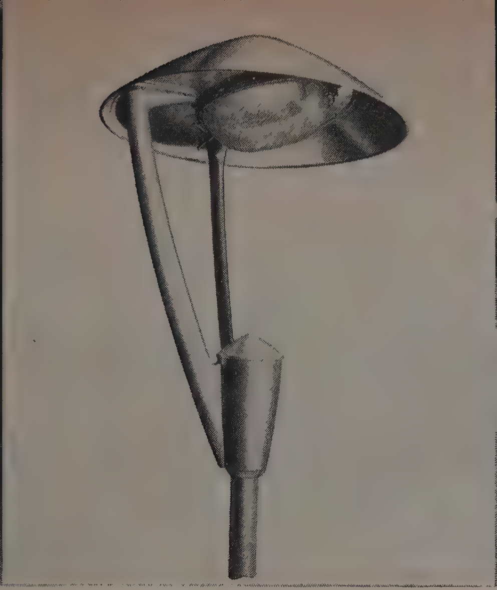
McGRAW-EDISON

Outdoor

506

DISTRIBUTION TRANSFORMERS • RECLOSERS, SECTIONALIZERS AND OIL SWITCHES • FUSE CUTOUTS AND FUSE LINKS • LIGHTNING ARRESTERS • POWER SWITCHING EQUIPMEN
PACKAGED SUBSTATIONS • CAPACITORS • REGULATORS • OUTDOOR LIGHTING • LINE CONSTRUCTION MATERIALS • PORCELAIN INSULATORS • FIBRE PIPE & CONDUIT

s EXCLUSIVE PTL luminaire, hand-
ely styled for parks, playgrounds,
els, hotels, estates. Scientific
cal system. Seven IES light pat-
s to 10,000 lumens incandescent
50 watts mercury. Six colors and
hed aluminum.



THE OUTSTANDING LIGHTING unit on the market today is L-M's exclusive "Styled Mercury" luminaire. 1000 or 700-watt lamps provide high level lighting for shopping centers, streets, large parking areas, for lighting and appearance.

L-M STYLED FLUORESCENT luminaires provide efficient even glare-free lighting. This entrance road and front parking area lighting were engineered by L-M Engineers especially for the Pennsylvania Railroad Truc-Train Terminal, Chicago.

ontemporary Styling, High Quality

esigns are styled by noted industrial designers. L-M offers wide variety for every need.

M offers many services through Authorized L-M Dis-
butors:

- Complete Product Information
- Technical Information
- Application Engineering Service

tstanding is L-M Lighting Application Engineering
rvice, available through Authorized L-M Distributors.
hatever your outdoor lighting problem, L-M engineers
ll help you solve it. L-M has more than 100 Field
gineers, who are backed by field service lighting special-
s, and L-M's lighting engineering department.

k Your Distributor for Specifications or Mail Coupon
t complete information on L-M Outdoor Lighting
uipment. Ask your electrical distributor; call the near-
L-M office; or mail the coupon below for information
d the name of nearest Authorized L-M Distributor.

.506-R

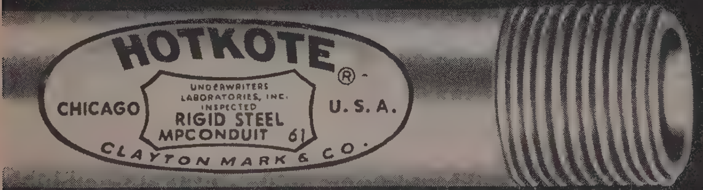
L-M OUTDOOR LIGHTING—Line Material advertising appears regularly in magazines reaching utilities, municipalities, architects, consulting engineers, managers and owners of shopping centers and public and private buildings, and a number of commercial establishments.

ndustries
OMPANY
ighting

McGRAW EDISON

Lighting Division, Line Material Industries, ECM-71
Milwaukee 1, Wisconsin
Please send information on the following L-M Outdoor Lighting Units:
☐ Also please send specifications
_____ Lawn-Glo Lights _____ Post Top Light _____ Styled Mercury
_____ Fluorescent Units
Name_______________
Company_______________
Address_______________
City_______________State_______________
Type of area to be lighted

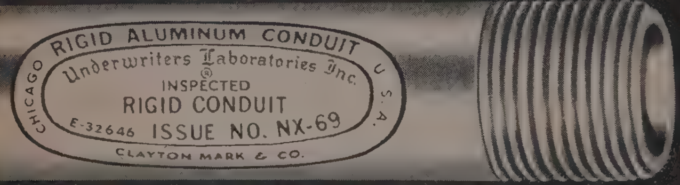
ELECTRICTUBE EMT—Satin-finish, close-grained, electro-galvanized EMT has exceptionally long corrosion-resistant life. Super-smooth interior surface permits easy fishing of wire. Bends easy . . . saves money on job. U/L Approved and meets Fed. Spec. WWT 806b.



HOTKOTE—Special, hot-galvanized exterior and interior surfaces provide bond with concrete and allow easy pulling of wires. Threads hot galvanized after cutting to prevent rusting. U/L Approved and meets Fed. Spec. WWC 581c.

GALVAKOTE—Electro-plated pure zinc exterior, including threads, prevents corrosion, assures long life. Interior surface evenly coated with baked-on enamel to provide smooth finish for easy "fishing." Will not flake or chip. U/L Approved and meets Fed. Spec. WWC 581c.

ENAMELKOTE—Both interior and exterior surfaces coated with high-grade, baked-on black enamel. Bends, cuts and threads easily without flaking. Accurately cut standard gauge threads. U/L Approved and meets Fed. Spec. WWC 571a.



ALUMINUM—Lightweight, corrosion-resistant, easy to bend and cut. Color-coded thread protectors for size identification. Cuts handling and labor costs. U/L Approved.

FROM MANUFACTURERS
OF CONDUIT SINCE 1910

a complete line of high-quality conduit to meet all requirements

Every electrical distribution system you install must give years of safe service, and deserves the finest material you can put into it. That's why Clayton Mark conduit and electrical metallic tubing has been the natural choice of designers and installers of electrical systems for almost half a century.

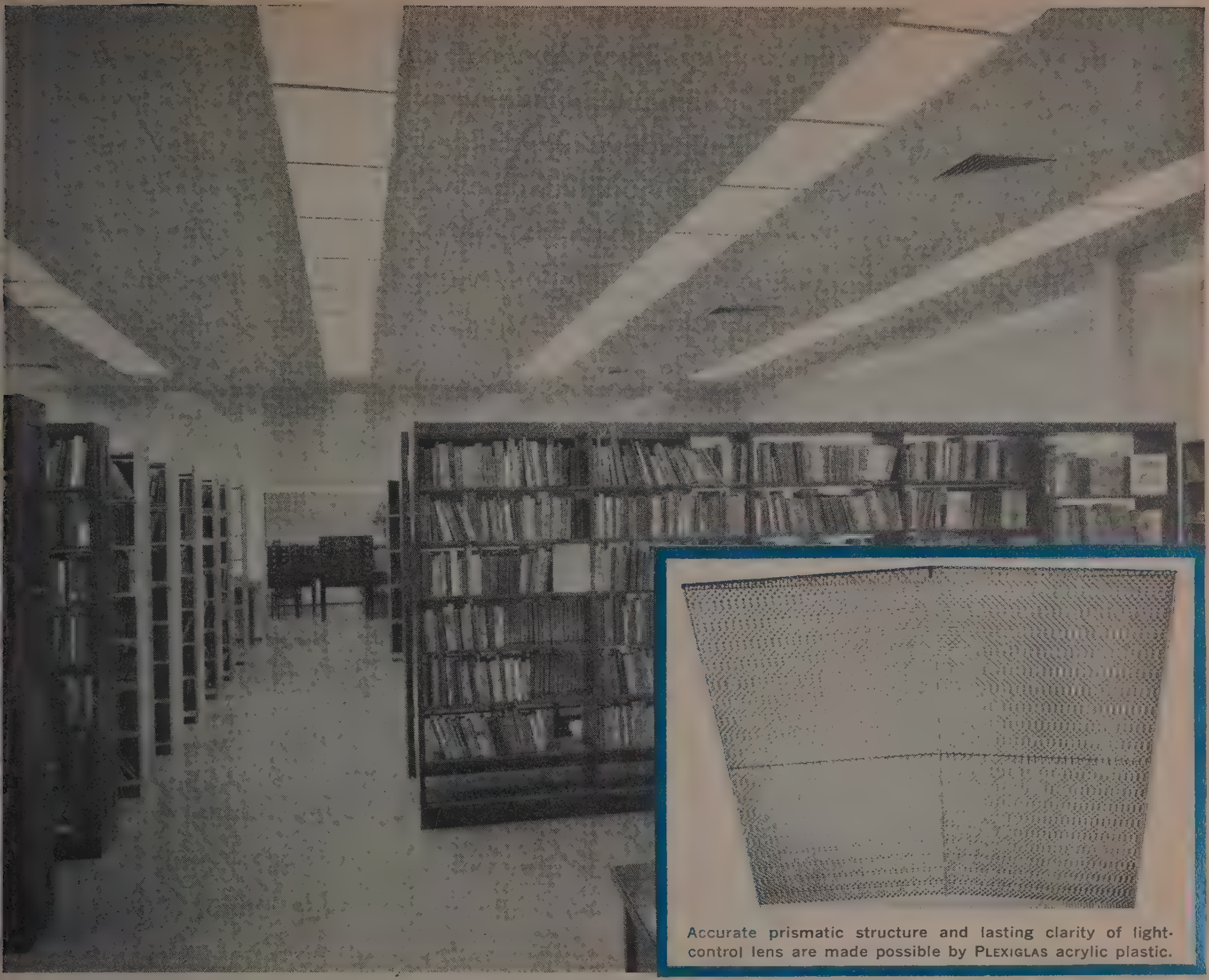
All Clayton Mark conduit is inspected by Underwriters' Laboratories to assure high continuity of excellence. Every foot is made of special quality material which threads, bends, and cuts easily. Threads on pipe, elbows, and couplings are accurately cut standard gauge to assure proper fit. Male threads are covered with thread protectors to prevent damage before being placed in service. And all Clayton Mark conduit is thoroughly cleaned for perfect adherence of interior and exterior coatings.

Remember to ask for safe, long-lasting Clayton Mark conduit for your next job. You'll save time, money and effort. Call your local distributor today.

Distributed in all 50 states and throughout the world

CLAYTON MARK
& COMPANY
1900 DEMPSTER STREET • EVANSTON ILLINOIS • U S A

AB-2677



Accurate prismatic structure and lasting clarity of light-control lens are made possible by PLEXIGLAS acrylic plastic.

Control lenses molded of PLEXIGLAS mounted in continuous rows in library of County of Sonoma school administration building, Santa Rosa, California. Architects: Steel & Van Dyke, Santa Rosa.

Plexiglas...for lighting that stands out and stands up

When lighting equipment includes control lenses molded of PLEXIGLAS® acrylic plastic, the result is illumination of the highest quality. This is because PLEXIGLAS makes possible a precisely designed optical element that directs light to the area where it is required and, at the same time, minimizes the surface brightness of the lens as seen from normal viewing angles.

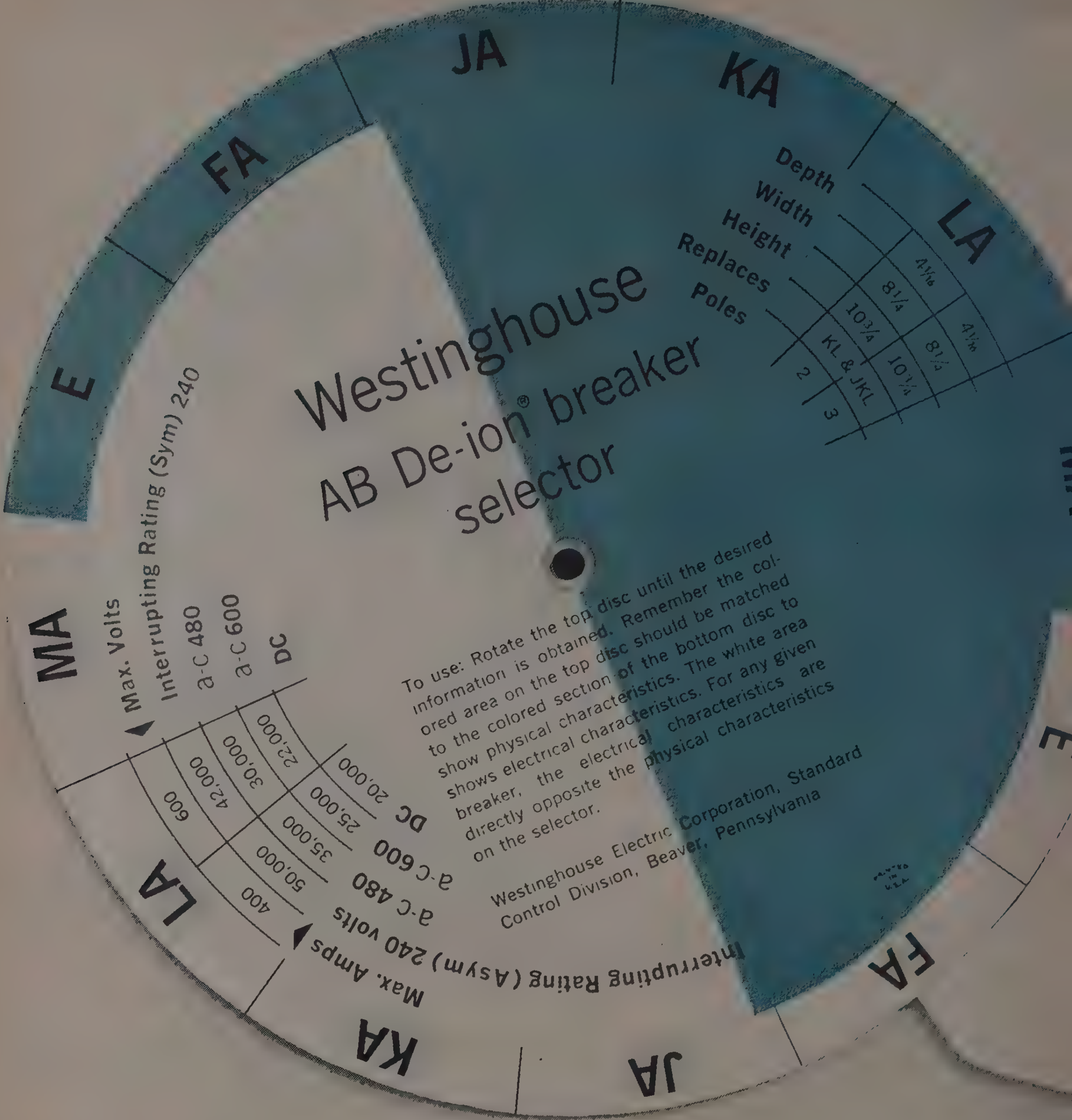
In addition, lenses of PLEXIGLAS remain free of discoloration even after years of exposure to fluorescent light. They are strong and rigid yet light in weight, resulting in safety overhead and ease of maintenance. And the crystal clarity of PLEXIGLAS assures full utilization of light.

Full details on the use of PLEXIGLAS as a lighting material are contained in our 40-page technical bulletin "PLEXIGLAS for Lighting". We will be glad to send you a copy.

ROHM & HAAS
PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Co. of Canada, Ltd., West Hill, Ontario*

PLEXIGLAS



Westinghouse AB De-ion® breaker selector

	LA	
Depth	4¹⁄₁₆	4¹⁄₁₆
Width	8¼	8¼
Height	10¾	10¾
Replaces	KL & JKL	
Poles	2	3

	LA
Max. Volts	600
Interrupting Rating (Sym) 240	42,000
a-C 480	30,000
a-C 600	22,000
DC	

	LA
Max. Amps	400
Interrupting Rating (Asym) 240 volts	50,000
a-C 480	35,000
a-C 600	25,000
DC	20,000

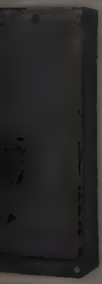
To use: Rotate the top disc until the desired information is obtained. Remember the colored area on the top disc should be matched to the colored section of the bottom disc to show physical characteristics. The white area shows electrical characteristics. For any given breaker, the electrical characteristics are directly opposite the physical characteristics on the selector.

Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania

PRINTED IN U.S.A.

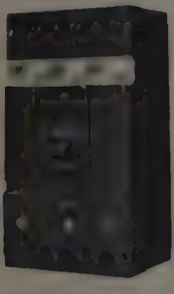
GOOD DEAL ON A WHEEL

his selector wheel makes it easy for ou to identify and specify the world's ewest and most complete line of ircuit breakers. Get one free from our Westinghouse representative r write to Westinghouse Electric orporation, Standard Control Divi- ion, Beaver, Pa. You can be ure . . . if it's Westinghouse

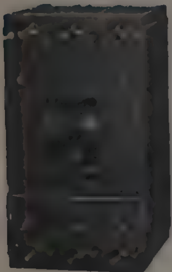


5* . . . interrupts
,000 amps at 240
c, and costs only
n of conventional
terrupting capac-
kers. Excellent
ork systems.

TRI-PAC* . . . smallest, lowest cost protective device you can apply where 100,000 amps can be poured into faults—e.g., network or large transformer-fed systems.



SAF-T-VUE* . . . lets you see whether the contacts are open or closed. Fills the needs of every industrial plant where safety codes require visible contacts. All frame sizes.



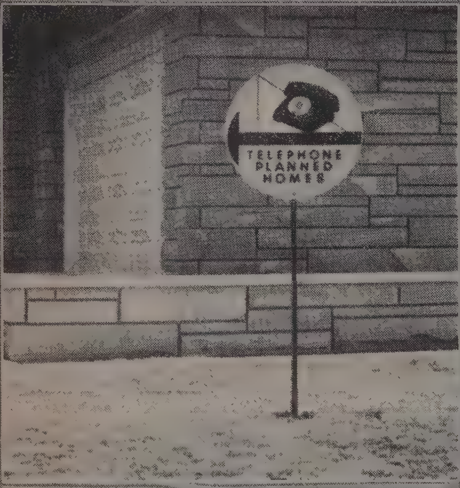
AMBIENT COMPENSATED . . . ends nuisance tripping, and eliminates need for derating where elevated or changing temperatures are encountered. All frame sizes.

MAGNETIC ONLY . . . provides short circuit protection only. Primarily used on motor circuits where overload protection is provided by other means. All frames but E.

THERMAL MAGNETIC . . . provides instantaneous opening on short circuits. On sustained overload, the higher the current the shorter the opening time. All frames.

J-30325

"Telephone planning helps me sell houses," says Sam Batistich. "People are looking for extra conveniences—and this is a good one. It gives my salesmen an important talking point. Everybody likes it."



Your local Bell Telephone Business Office will gladly help you telephone-plan your homes. For details on home telephone installations, see Sweet's Light Construction File, 11c/Be. For commercial installations, see Sweet's Architectural File, 34a/Be.

"Modern ideas? One of the best I know is concealed telephone wiring—in every house"

SAYS SAM BATISTICH,
SAM BATISTICH CONSTRUCTION CO.,
RIVERSIDE, ILL.

"We specialize in modern, ranch-type homes. We advertise that our homes have 'the best ideas in modern design.' And our prices range from $40,000 to $70,000. This means that our customers expect our homes to have all the latest conveniences. One of the most important—and promotable—of these is concealed telephone wiring.

"People know about telephone planning. And they respond quickly—and favorably—when they see it in Sunny Hills Estates. All of our 238 houses feature concealed telephone wiring. That's the kind of preplanning my customers appreciate.

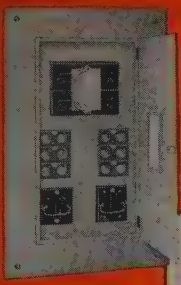
"Yes, concealed telephone wiring is a convenience feature that makes sense. I've been putting it in for some time now . . . and I'm convinced it helps me sell houses."

BELL TELEPHONE SYSTEM

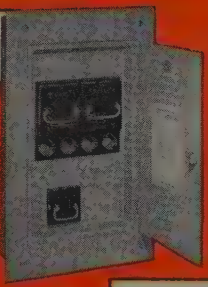
Completely air conditioned—and telephone planned—the modern, luxurious "Sherwood" is priced at $53,000.

Money-Maker!

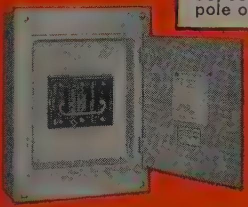
FRANK ADAM Factory-Assembled RESIDENTIAL SERVICE EQUIPMENT



100 Amp. main pullout plugs & 2 or 3 pullout branches (30 or 60A)



100 Amp., main, range lighting plugs & water heater or air conditioning



Individual pullout 30, 60 or 100 Amp. 2 pole or 3 pole

60 Amp. pullout 4 to 10 plugs

60 or 100 Amp. gang type pullouts for multi-family main service

Assembled and packaged at the factory, ready to install—Frank Adam Residential Service Entrance Equipment saves money for you, makes money for you:

1. A single catalog number gets a *complete unit* from your supplier, exactly as you want it, as fast as you want it.
2. Installation time is cut down, plus all the time it takes your electricians to straighten out and assemble a pile of individual parts.
3. Errors are eliminated in listing and ordering components by separate catalog numbers.
4. Mistakes in supplier deliveries are prevented—saved are hours wasted in reordering and waiting for what should have been delivered the first time.

Equally important is the extra money you make on the time you save with factory-packaged units, you can get the industry's finest at sharply competitive prices. Give your customers the best as long as they are paying for it—order and insist on Frank Adam Electrical Equipment.

KEEP PACE ELECTRICALLY

THE PRODUCERS COUNCIL AFFILIATED WITH THE AMERICAN INSTITUTE OF ARCHITECTS

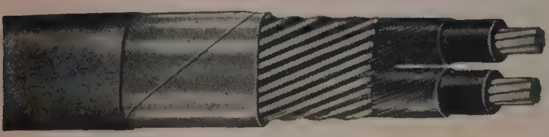
FRANK ADAM ELECTRIC COMPANY
SINCE 1891
P. O. BOX 357, MAIN P. O. • ST. LOUIS 66, MO.

Busducts • panelboards • switchboards • service equipment
safety switches • load centers • Quikheter

MAKE THE CHANGE AND COUNT YOUR SAVINGS

See how the switch from copper to Rome's *aluminum* service entrance cable can improve your competitive position.

It's a fact: Aluminum service entrance cable usually costs less than copper cable required to do the same job. Just how much less depends on service, size and the amount of each kind of cable you use. Check the tables on the right and compare the difference between the cost of copper and the equivalent in Rome's aluminum service entrance cable. Then multiply the difference by your requirements. There's your saving—and no question about it. And don't forget that aluminum's light weight makes it easy to handle. The weight it saves is weight you'll *never* have to heft, load, unload and carry to an installation site! The savings in dollars and ease of installation speak for themselves. If you'd like the complete story on performance, availability and installation, contact your nearby Rome distributor or sales representative. Rome Cable, Division of Alcoa, Dept. 7-71. Rome, New York.

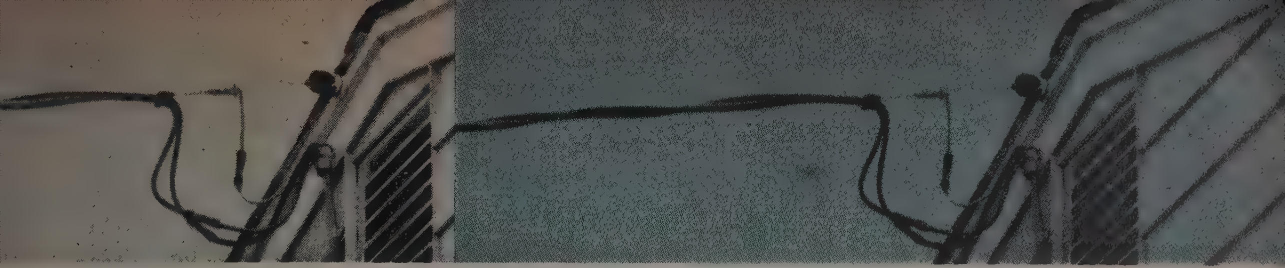


ALUMINUM service entrance cable from the Rome Cable Division of Alcoa is available in two- or three-conductor types, insulated with Underwriters-approved heat- and moisture-resistant compound. The insulated conductors are enclosed in a color-coded protective tape. The concentric conductor consists of a spirally applied conductor having a circular mil area equivalent to the AWG size specified for the neutral conductor.

ALCOA

ROME CABLE

DIVISION



ROME SERVICE ENTRANCE CABLE

THREE CONDUCTOR • TYPE "SE" • STYLE "U"

Underwriters Approved

COPPER			ALUMINUM			SAVINGS	
RCUIT ATING AMPS	INSULATED CONDUCTOR SIZE AWG	LIST PRICE PER 1000 FT.	CIRCUIT RATING IN AMPS	INSULATED CONDUCTOR SIZE AWG	LIST PRICE PER 1000 FT.	DOLLARS	PERCENTAGE (Approx.)
60	6	241	60	4	235	6	2%
00	3	407	100	2	303	104	26%
25	1	784	125	1/0	472	312	40%
50	1/0	947	150	2/0	520	427	45%
00	3/0	1390	200	4/0	704	686	49%

in this day of

Prismatic
Light Control

Art Metal has the most
complete line of
commercial incandescent
prismatic lenses in
the industry

WAKEFIELD
CORPORATION

[illegible]
Art Metal Lighting Division – Cleveland 3, Ohio
1814 East 40th St.
Wakefield Lighting Limited – London, Ontario

[illegible] Lighting Division – Vermilion, Ohio
[illegible] Electric Company – Ravenna, Ohio

WIREMOLD® ELECTRIC IDEAS

PREPARED EACH MONTH FOR ELECTRICAL CONSTRUCTION AND MAINTENANCE
TO BRING IDEAS, NEWS AND HELPFUL INFORMATION TO ELECTRICAL MEN

62nd YEAR

JULY 1961

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PRACTICAL TIPS .... FOURTH PAGE

Automated Offices Require Available Electric Power

Electronic and electrical office machinery depends upon conveniently located outlets

"Automation," a word usually associated with factories and plants, has made its mark felt in modern offices throughout the nation. And, like plant mechanization, it requires available electrical power to make it work.

Electric typewriters, accounting machines, bookkeeping machines, data processing equipment have all become commonplace in offices. They have added greater efficiency and better working conditions. Without exception, however, they require plenty of conveniently located receptacles if they are to be of maximum value.

To solve the problem of having enough outlets and sufficient flexibility to permit moving machines from one location to another, many office planners have decided on multi-outlet assemblies. These surface wiring systems assure the user of enough outlets to permit adding

continued on next page

MODERN OFFICES call for conveniently available electric power to operate typewriters, data processing equipment and other conveniences. Multi-outlet systems permit easy access to power at the same time they provide flexibility for the future.

Code Comments

Remote Control and Signal Circuits

Q. *Can conductors of different systems be run in the same raceway?*

A. Section 725-16 of Article 725 of the Code reads, "Conductors of Different Systems. Conductors of two or more Class 1 remote-control and/or signal circuits may occupy the same enclosure or raceway without regard to whether the individual systems or circuits are alternating or direct current, provided all conductors are insulated for the maximum voltage of any conductor in the enclosure or raceway. Conductors of remote-control, low-energy power and signal circuits, in which the current is limited as for Class 2 systems, shall be considered as Class 1 system conductors for the purpose of this requirement if insulated and installed in accordance with the provisions for Class 1 system conductors. Power supply conductors may occupy the same enclosure or raceway with Class 1 system conductors when supplying only equipment to which Class 1 system conductors are connected."

Residential Outlets

Q. *How many outlets can I put on a circuit in a residential installation?*

A. The National Electrical Code does not limit the number of general purpose outlets that may be installed on a given circuit for residential wiring.

WIREMOLD®

Advertisement

Editorial

Is "essentially" safe enough?

Our sincere congratulations to the Adequate Wiring Bureaus which are in the forefront of the struggle for good electrical service.

As these groups point out, the National Electrical Code, in Article 90-1(b), states: "This code contains basic minimum provisions considered necessary for safety. Compliance therewith and proper maintenance will result in an installation *essentially* free from hazard, but not necessarily efficient, convenient or adequate for good service."

While no one would deny that safety should be the primary consideration, there is no doubt that the user expects more than that. An installation that is efficient, convenient and adequate for good service should be the aim of all.

Product of the Month

UL increases rating of wire connector

Underwriters' Laboratories is now listing the Wiremold W30 Wire Connector with an increased rating of 600 volts. The new rating also permits the W30 to be used for 1,000 volts inside a fixture or sign.

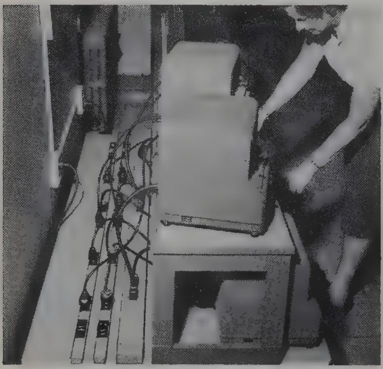
This new listing greatly extends the utility of the pressure-type connector from its original rating of 300 volts.

Probably the only connector of its kind, the W30 is for making T-splices without twisting, soldering or taping. It is intended for common connections of 2, 3, or 4 No. 14 AWG or No. 12 AWG solid conductors.

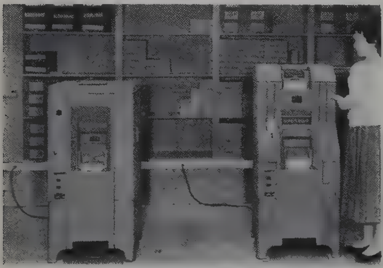
One of the features of the 1 5/16 x 1/2-in. connector is the ease with which it can be used. The wire is stripped to the width of the connector and inserted as far as it will go. The conductor cannot pull out or work loose. A strip gauge is molded into each device. The W30 is available from distributors in cartons of 10 or 50.

Automated Offices Require Available Electric Power

continued from preceding page



REMOTE CONTROL dictating systems also require plenty of outlets. This system in the home office of a major insurance company uses three parallel runs of Plugmold.



UP-TO-THE-MINUTE information is vital in a county sales tax office and this Plugmold run assures plenty of outlets for placement of data processing machines.

new equipment and, at the same time, eliminate the need for long, dangling wires and dangerous extension cords.

Office decor, too, is undisturbed since the raceway blends in with the room decoration.

Specifying multi-outlet systems means that future re-circuiting, if necessary, is a simple job and the need for disturbing office routine to permit wall-breaking and redecoration is virtually done away with — a fact appreciated by all office managers. Machine operators, too, appreciate not having to hop-scotch over trailing electrical cords. Grounding receptacles are often needed, too, and are readily available with Plugmold systems.

Automation in the office is here to stay. It is up to the installer and specifier to make certain that the necessary power will be available — conveniently, safely and adequately. Plugmold multi-outlet systems provide the ideal power source for the modern office.

PLUGMOLD eliminates long, dangling wires and dangerous extension cords. At the same time, it permits convenient placement of office equipment and machinery

WIREMOLD®

Advertisement

Quiz Corner

Q. *What type of junction box must be used to feed Plugmold 2000 or may a splice be made in the Plugmold?*

A. Splice may be made in raceway. No. 2014 and No. 2014E Splice Covers are available for use when feed comes through the back of the raceway. No. 2010A Entrance End fitting with ½″ KO's on end and both sides is available for use when feed comes through the end of the Plugmold run.

Q. *Is the 2127G Grounding Receptacle available in ivory?*

A. Yes. Specify 2127GV.

Q. *Is there such a thing as a "gold-plated" grounding system for Plugmold? An electronics manufacturing customer of mine says he heard there is.*

A. Not literally "gold-plated." Another term for it would be "super-deluxe." And it's especially for the electronics field, where they occasionally need a super-grounding system to eliminate undesirable side effects of noise and electrical interference, sometimes caused by grounding resistance, on delicate electronic instruments in extremely critical installations.

Standard grounding type Plugmold 20G and 22G series with their positive grounding terminal are wholly acceptable in all normal circumstances. Now, for these special situations, Wiremold has introduced the 20GB and 22GB series, which provide, additionally, a solid copper grounding wire continuous to the panel.

This gives precision testing laboratories fresh opportunities to utilize the other desirable features of Plugmold, already so widely adapted for lab use.

Q. *Can a grounding receptacle be installed in Plugmold 1900?*

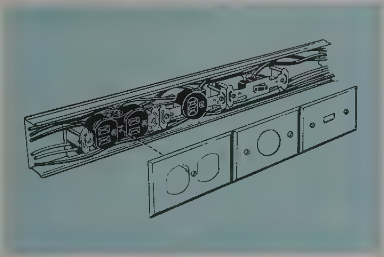
A. No, use 2000.

Q. *Does Wiremold make a lumiline fixture?*

A. No, but 2127D Lumiline Receptacles, Reflectors, and Cover Sections are available for assembling lumiline units from No. 2100 in the field. See pages 96, 100, and 102 of Catalog 22.

Q. *Are special flush plates required when using 3007C Device Bracket?*

A. No. Wiremold 3000 accepts standard flush plates which are mounted in raceway with 3007C.



WIREMOLD ■ HARTFORD 10, CONN.
Gentlemen: Please send me checked items

NAME ____________________

COMPANY ____________________

ADDRESS ____________________

____

☐ Re-Wiring 40-Year Old Schools
☐ Apartment House Wiring Data Sheet (C9)
☐ Electric Ideas, June 1961
☐ Electric Ideas, May 1961
☐ Wiring Guide (Catalog 22)

E1-7

Newsworthy

With so many of the Wiremold staff participating in NECA-IBEW apprentice training and similar vocational programs, people hearing about it have asked what the presentation is.

Basically, it consists of a live presentation by a Wiremold man, a selection of samples, and a 16-page illustrated flip chart which uses the Wiremold line to explain surface wiring systems. Slides, sound movies, and other training devices also are used. A skilled lecturer, often an engineer, makes the presentation and then answers any questions.

Based on Wiremold products, the presentation is informative and technically accurate. The main purpose of participation in the program is to acquaint tomorrow's contractors with the concept and proper use of surface systems.

The lecture is divided into three basic sections: definition of surface metal raceways, types, and installation.

Under *definition*, the point is made that the major function of surface raceways is to mechanically protect electrical conductors for light, power and communication wiring.

Ceiling and wall raceways of both the one and two-piece types are discussed in the second section. Also covered are multi-outlet systems and overfloor varieties.

The major emphasis, however, is placed on installation, with the lecturer stressing that "an orderly surface metal raceway installation is visual evidence of the electrician's skill."

To help the novice, hints on installation techniques are given which cover alignment, fastening and coupling, cutting raceway to length, bending for simple offsets, coupling raceway to fittings, how to pull in conductors, and tips on completing the installation.

As its contribution to the industry drive for better workmanship, Wiremold is pleased to cooperate with all recognized training programs.

WIREMOLD®

Advertisement

Engineered Specials

Special Wiremold box developed for bowling lane units

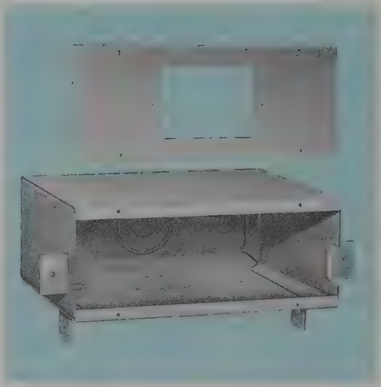
PROBLEM:

To provide a suitable means for carrying conductors for the Tel-E-Foul, automatic ball lift, hand-dryer, and Tel-E-Score units for a basic layout of 24 bowling lanes.

SOLUTION:

A special box, ED-5554-A, was developed which, when used with Wiremold 2100, provided the necessary flexibility for the installation. The unit was designed so that local contractors could install it without difficulty.

DISCUSSION:



Each of the bowling devices has different power requirements, but all operate on 115-v. A Tel-E-Foul unit (pair of lanes) requires 1 amp. Four of these units are permitted on one circuit, with every two units switched from the operator's desk. The automatic ball-lift operates on 6 amps.; the hand-dryer, with push-button switch, 1½ amps.; and the Tel-E-Score unit (pair of lanes) on 7½ amps. Each Tel-E-Score is switched individually from the operator's control desk.

Working with engineers of Brunswick Corporation's bowling division, Wiremold engineers developed the special box (see illustration) to provide a junction for the wiring in the conduit, which runs under the floor, and the wiring in the 2100 raceway, which is surface-mounted. Wiring for the three bowling devices is under each lane, while the power wiring from the panel is carried to all lanes through the raceway.

The box is mounted flush to the vertical step riser at the lane approach; the Wiremold runs along the length of the riser. The cover plate to the box contains a cut-out for mounting any standard device. Frequently, it is desirable to have a receptacle at this location for floor polishers and vacuum cleaners.

Wiremold engineers are pleased to cooperate in the development or modification of Wiremold products to meet special requirements.

USEFUL LITERATURE

Check coupon on preceding page for copy of listed item.

Data Sheet C9

Details on the use of Plugmold 2200 and Wiremold 700 and 500 to provide a complete wiring system in a 42-building, 250-apartment low cost housing project are given in this recently-released bulletin.

WORTH READING

Check coupon on preceding page for copy of listed item.

Re-Wiring 40-Year-Old Schools, Contractors' Electrical Equipment, May 1961. A case history showing how surface raceway system proved economical in the re-wiring of a 5-building school complex.

Practical Tips

Contractor builds handy, traveling work benches

To save a lot of trips back and forth to the truck to pick up parts, Cowles Electric Co., Hartford, Conn., has built four portable work benches.

Basically for use on remodeling jobs, these 4-foot long benches hold all kinds of materials and parts commonly used by electricians. There are 18 good-sized drawers, with compartments to hold parts. There is also room for a wide assortment of tools — including such tool kits as a KO punch set, stud driver, and masonry plug kit.

The benches are made of slotted angle irons. A handle and wheels make it easy to bring the "Porto-shop" as Mr. Cowles calls it, right to the job site. Covers on both sides slide up under the top and out of the way. When not in use, the covers can be closed and locked.

WIREMOLD®
HARTFORD 10, CONNECTICUT

All WIREMOLD products are sold through electrical distributors — your best source for all electrical products.

Advertisement

First from General Electric (1959)...another bright idea that became a better lamp for you

G-E All-Weather Fluorescents shine brighter when mercury drops

Mister Magoo says . . ."1959? A chilly year! Alaska joined the Union, and General Electric invented the All-Weather fluorescent. Happy birthday, All-Weather. Humph! Packaging experts! Who needs a wrapper on a pool cue?"

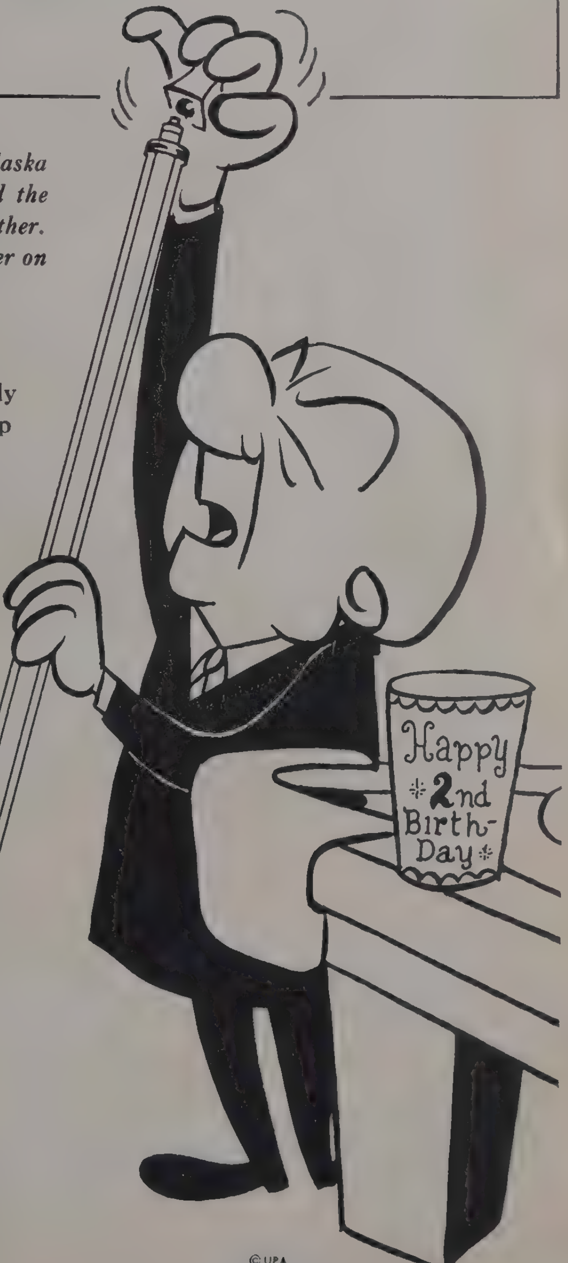
DON'T drop your cue, Mister Magoo. It's a specially jacketed All-Weather lamp, another first chalked up by General Electric.

It wears that glass jacket to ward off winter wind and cold. Below freezing, it's the most powerful fluorescent lamp your customers can buy.

General Electric developed this lamp because ordinary fluorescents grow dim when the temperature dives toward zero. Often they lose 90% or more of their warm-weather light output. But the All-Weather fluorescent T10J—a G-E exclusive—grows brighter the colder it gets! Use it where temperatures sometimes drop below 40°F.

Your customers can use the T10J—or its companion lamp (T10) without the "storm window"—indoors or out. Examples: walk-in freezers, shopping centers, drive-ins, parking lots, street lamps, store fronts, airports, docks, signs, gas stations.

Both come in 4′, 6′, and 8′ lengths. Ask your G-E distributor to show you these two exclusive examples of General Electric lighting leadership. General Electric Co., Large Lamp Dept. C-111, Nela Park, Cleveland 12, Ohio.



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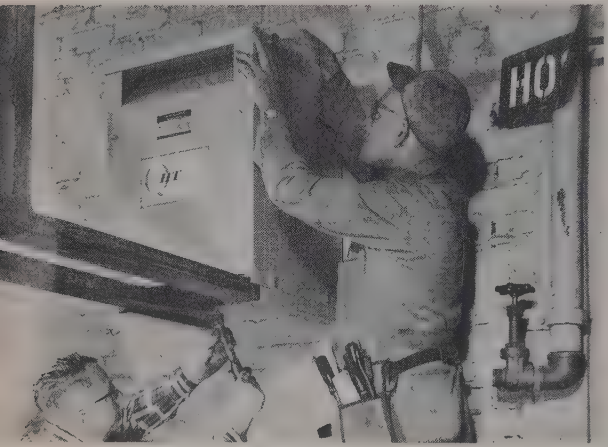
PICTURES, INC.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Transformers are shipped on pallets which makes it easy for you to use a fork truck to position General Electric QHT dry-type transformers for mounting.



Keyhole slots hold QHT transformer in place. Built-in mounting provisions eliminate need for wall brackets.

Hook up this General Electric QHT transformer in only 18 minutes

You save time and money every time you install a General Electric QHT dry-type transformer.

First, QHT transformers are easy to handle. They offer savings up to 50 percent in weight and 67 percent in size compared with other dry-types. You can place QHT units near the load and save the cost of long, low-voltage feeders. They don't require vaults, barriers, or ventilating fans.

Entire front panel is removable to expose all terminal and tap connections. All connections are up front.

Second, you wire QHT transformers from the front. There's a complete wiring diagram on the nameplate. Dual-sized conduit knockouts are placed so that you can run cable straight into the connectors. And large, roomy terminal compartments, solderless connectors, and numbered terminals help you to complete wiring in 18 minutes.

The new General Electric QHT dry-types are quiet—at least 15 decibels quieter than older designs, making them ideal for schools, hospitals, office buildings, and other places where noise could be a problem. All QHT units have sound ratings equal to or less than NEMA standards. On larger units, welded steel clamps minimize core vibration. The core assembly is mounted on built-in rubber pads to reduce noise transfer through conduits and mounting brackets.

You can get 24 hour delivery on most models from your nearby General Electric distributor. For more information, call him today or write to Section 411-17, General Electric Co., Schenectady 5, N. Y.

* Registered trademark of General Electric Co. for quiet, high-temperature dry-type transformers.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Here is the tool that permanently anchors a 2 x 4 to concrete with less than ten taps of a hammer. Without drilling or plugging.

It's called Shure-Set.®

It does plenty of other fastening jobs too. Junction boxes, conduit clips, gutters. Heaters, signs, Wiremold. Using Shure-Set you can attach almost anything to concrete and other masonry materials. And you do it rapidly.

How is it possible? A special steel fastener is inserted at one end of Shure-Set, your hammer blow is directed against the large movable anvil at the other end. The easy-to-hit anvil concentrates the force of the hammer blow onto the fastener, but within the confines of Shure-Set's precision bore. The fastener can't waver or skew off. Every swing of the hammer drives it straight and true into the concrete. (Note: powder charges are *not* used in this tool.)

And Shure-Set's austempered steel fasteners *never* bend or break. Austempering has given them the ideal metallurgical properties for penetrating hard construction materials (it's the same heat treatment we give our *powder-driven* fasteners). These steel drive pins ("nails") and threaded studs make a strong, permanent, compressive bond to concrete. For a light-duty fastening, you won't find anything stronger.

And for the few cases—such as tile or glazed brick—where "tap-and-turn" work is unavoidable, a drill holder attachment is provided for converting Shure-Set into a superior masonry drill. Still another attachment fits it for use in fastening sheet metal to sheet metal.

Shure-Set is on its way to becoming a tool box standard because of its immense versatility. And because it pays for itself by saving time. Usually on the very first job. It also saves a lot of (put your own price on it) perspiration.

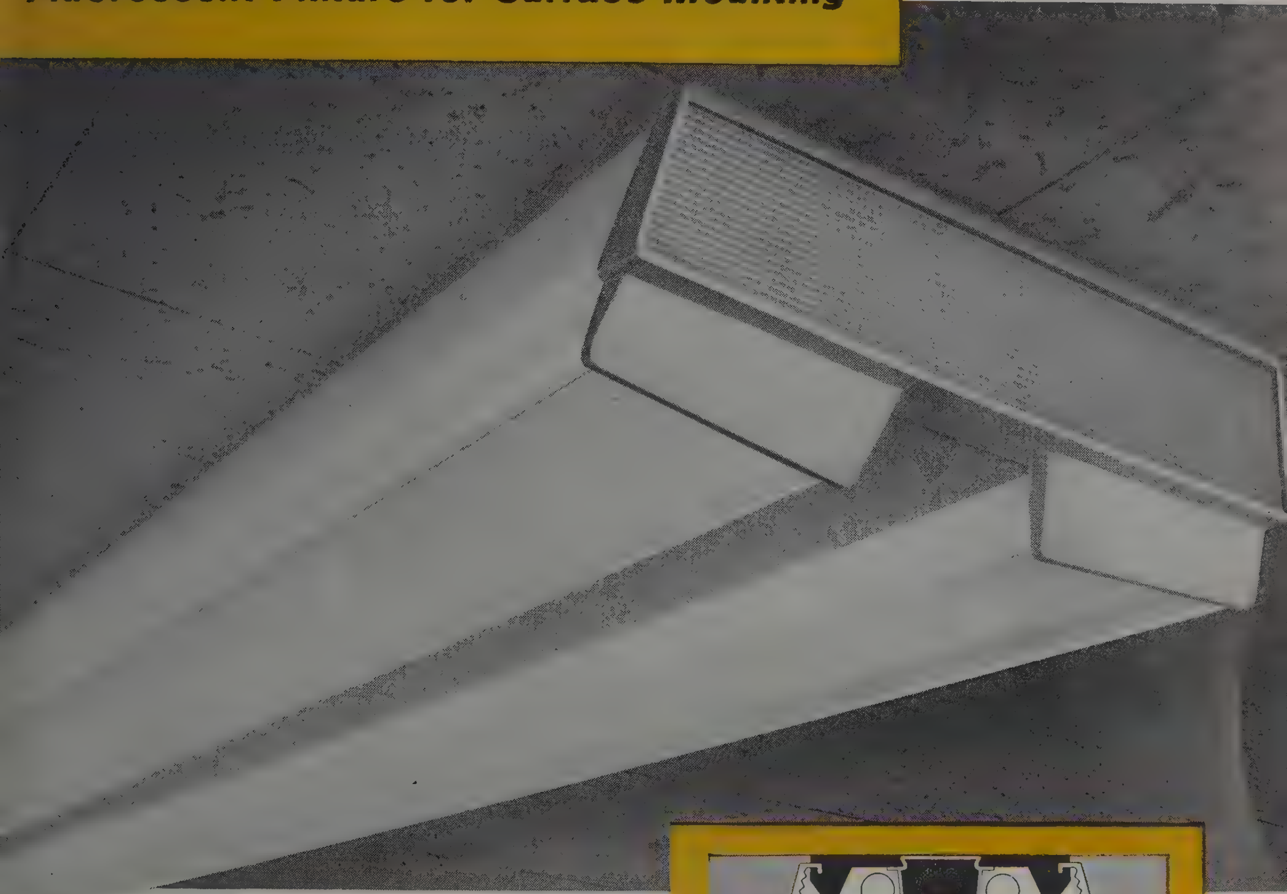
To find out where to buy Shure-Set nearest you, look under TOOLS in the Yellow Pages of your directory.

285-G Winchester Ave., New Haven 4, Conn. WINCHESTER-WESTERN DIVISION **Olin**

More seeing comfort by design . . .

NEVER BEFORE, SO MUCH SEEING COMFORT AT SO LITTLE COST *in a Plastic-enclosed Fluorescent Fixture for Surface Mounting*

Duplex-a-lite®
LIGHTING *by* miller

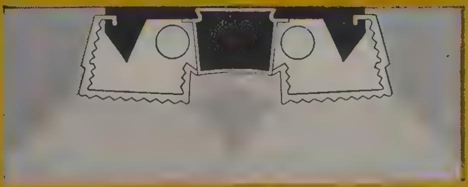


- Two lamp, 4′ and 8′ lengths; Rapid Start and Slimline. Clear Acrylic or light stable Polystyrene lenses. 13⁹⁄₁₆″ width.
- Self Hinging Plastic Enclosure for Each Lamp supported on both edges by continuous flanges in channel—Easy to Maintain—No Sag.
- Cooler Lamp and Ballast Operation—each lamp has its individual compartment widely separated by exposed metal channel which acts as a heat dissipator.

is altogether new and different looking fixture a precision lighting tool, optically designed optimum *seeing comfort* and economy . . . a formance feature we call Opticomfort. Du- x-a-lite controls and evenly distributes the nt amount of the right kind of light where it's eded most . . . puts more usable light on the rk or merchandise—less in the eyes. It is ecially suitable for schools, offices, public ldings and stores . . . wherever there's a need *seeing comfort* over prolonged periods of time.

truly unique combination of fresh, trim pearance and *seeing comfort* at a *modest* price . a natural for on-the-ceiling mounting in ver buildings where ceilings are low.

For complete information, write Dept. 661 S, contact your Miller Representative.



*Opticomfort** BY DESIGN

Another Miller First! Twin compartments separate and house each of Duplex-a-lite's two lamps in a unique manner that enables the optically designed, prismatic lenses to limit and control most of the light within the highly critical 45°-90° viewing zone. This assures optimum seeing comfort, or Opticomfort. Ceiling and center channel cover are softly illuminated. Enclosures of rigid plastic require no shadow-causing interior framework.

*Trademark

Patent Pending

LIGHTING BY
miller
SINCE 1844

THE **miller** COMPANY
MERIDEN, CONNECTICUT • UTICA, OHIO

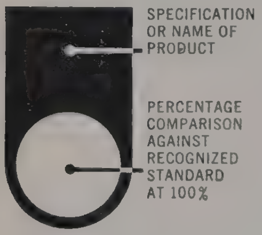
egistered Trademark—The Miller Company © 1961 The Miller Company, Meriden, Conn.

NEW WAY TO EVALUATE CABLE!

"VALUE RATINGS" RELATE PERFORMANCE TO IPCEA OR COMPETITIVE STANDARDS

New Value Ratings tell at a glance the composite story of each Kaiser Wire construction—as it performed in as many as 25 specified tests. In each case a well-known standard serves as 100%:

For power cable, the Value Rating standard is all IPCEA test requirements for types of insulation and jacketing specified . . . For portable cord, the standard is service-per-dollar for the least expensive cord (C.V.) as proved by life-expectancy tests.


SPECIFICATION OR NAME OF PRODUCT
PERCENTAGE COMPARISON AGAINST RECOGNIZED STANDARD AT 100%

. . . For control cable, the standard is a composite of minimum requirements for eight important insulation qualities.

Compared to these standards, Kaiser Wire constructions earn Value Ratings as large as 767%—valid proof that the spark of quality is Kaiser Wire experience.

For details and Value Rating listings, ask your Kaiser Wire Distributor for free K/W Value Rating Bulletins, or write: Kaiser Wire, Room 844g, Kaiser Aluminum & Chemical Sales, Inc., Kaiser Center, 300 Lakeside Drive, Oakland 12, California.

KAISER ALUMINUM & CHEMICAL CORPORATION

WORLD'S MOST MODERN VERTICAL C.V. UNIT TOWERS OVER OTHERS

The world's most modern . . . tallest . . . and largest vertical continuous-vulcanization line operates in a 126-foot tower at Kaiser Wire's Bristol, R.I., plant. It turns out K/W power cables ranging from 600 V. to 15,000 V.—with conductors dead center regardless of thickness or weight. It is topped by a six-inch rubber extruder . . . ends with a new high-pressure water cooling system that increases insulation density and improves corona level in K/W power cables.

K/W GRIZZLY® POWER CABLE SPEC. 831

VALUE
270%
RATING

MIRACLE OF LIQUID LATEX GUARDS KAISER LAYTEX® CONTROL CABLES

Coat after coat of liquid latex—applied in 100-foot vertical runs—gives K/W Laytex-insulated control cables unequalled value. The patented Laytex insulation process is the only one that applies virgin liquid rubber with its "liveliness" untouched by drying-regrinding cycles. Vertically applied concentric coatings eliminate any chance of weak, thin spots. Vulcanized Laytex has a remarkable insulation resistance constant of 75,000; typical tensile strength of 4,500 psi.

K/W LAYTEX-RESIN CONTROL CABLE

VALUE
767%
RATING

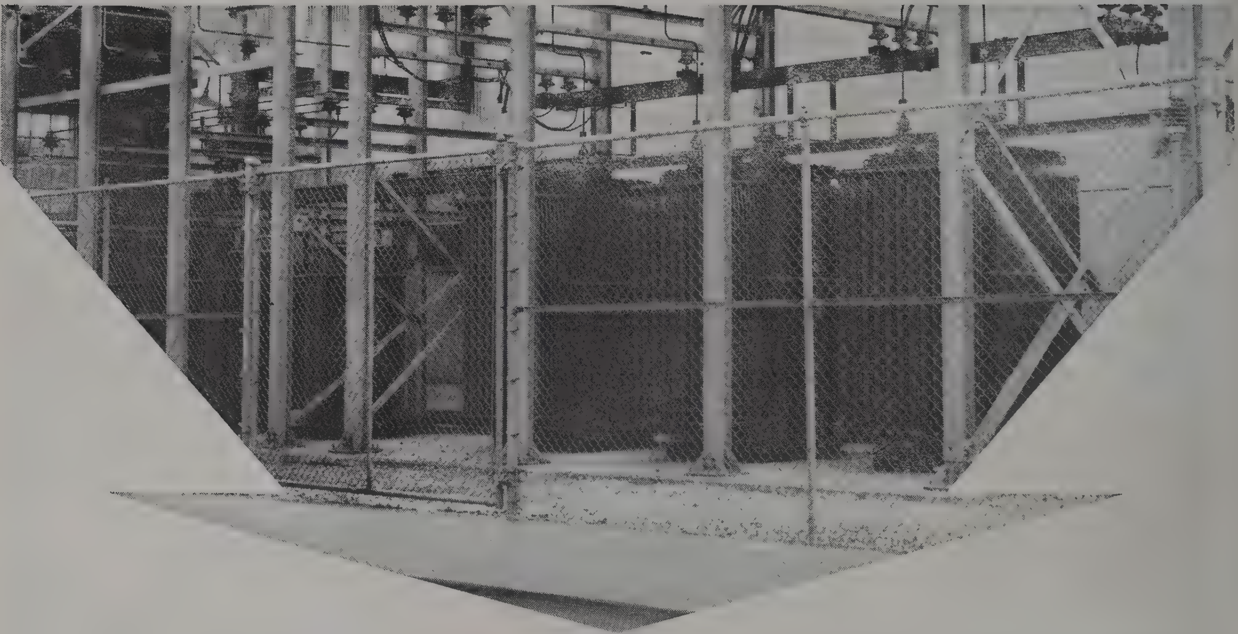
KAISER FIBROUS CORE HELPS THIS CORD FLEX 12 TIMES LONGER

A patented "cushion" core of soft fibre—at the center of the twisted copper conductor itself—is one reason why K/W Master Laytex portable cord survived 1270% more flexing cycles than the average low-priced product (C.V.) . . . 488% more than high-grade mold-cured competitive cords. Flexing is one of eight qualities adding up to *five times greater life* for K/W Master Laytex cord. In service per dollar this means 308% as much value as low-priced C.V.

K/W MASTER LAYTEX PORTABLE CORD

VALUE
308%
RATING

IN COPPER AND ALUMINUM CABLES... THE SPARK OF QUALITY IS KAISER WIRE EXPERIENCE! KAISER ALUMINUM



SIX WAGNER® TRANSFORMERS PROVIDE THE POWER

Here are six Wagner® transformers with a full-time job: providing all the power needed by a new electroplating line that produces tin plate for Granite City Steel Company.

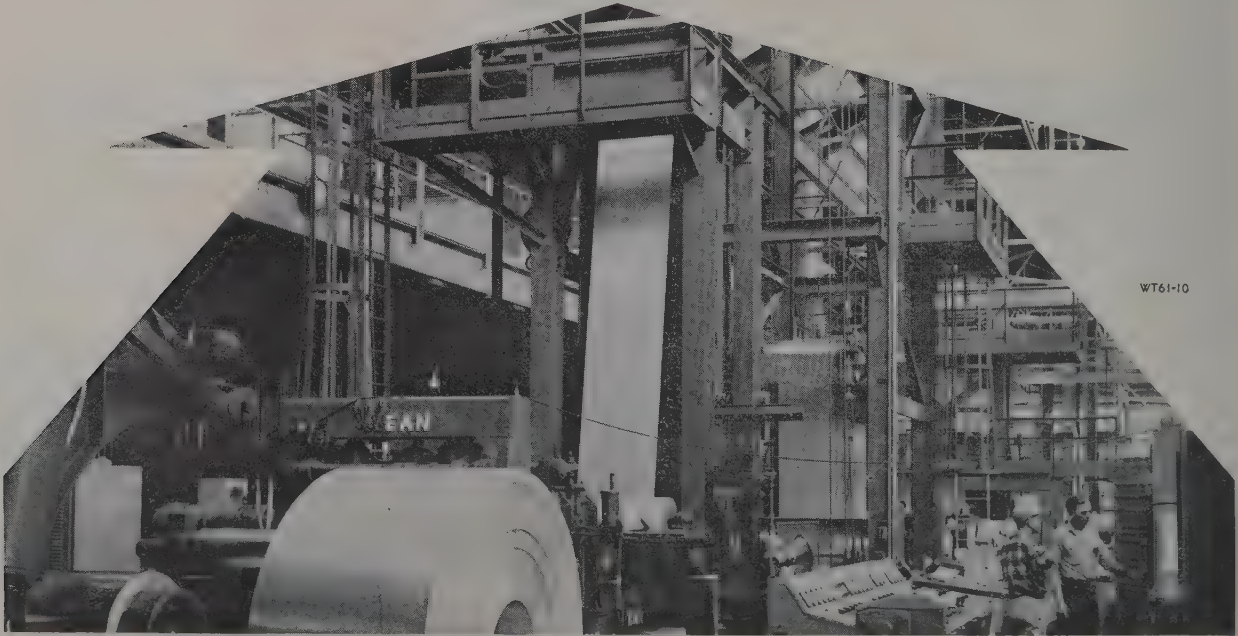
Three of the six supply power to motor-generator sets which convert to DC for variable speed drives, and to plating generation equipment and other major equipment drives. They are all 1667 kva, single phase, 60 cycles, 7200/12470Y to 2400/4160Y volts transformers.

The second set of three transformers are all 500 kva, single phase, 60 cycles, 7200/12470Y to 240 x 480 volts. They supply power for auxiliary pumps, etc.

All six are of the latest design . . . have wound cores of cold-rolled oriented grain steel. Their performance stability is outstanding. They're built to be trouble-free . . . built to provide all the power the plating line needs. Wagner transformers are designed to provide all the power you need, too. Your Wagner Sales Engineer can show you how. Call him. Soon.

Wagner Electric Corporation
6413 PLYMOUTH AVENUE, ST. LOUIS 33, MO., U.S.A.

FOR GRANITE CITY STEEL'S NEW TIN PLATING LINE



WT61-10

Here's the New ECONOMY Lug with QUALITY improvements ★

SHOWN ACTUAL SIZE—

The 7 sizes of PennLugs, Type PNL:

PNL 1000; 500 to 1000 MCM
PNL 500; 4/0 str to 500 MCM
PNL 300; 1/0 str to 300 MCM
PNL 4/0; 1/0 str to 4/0 str
PNL 1/0; 4 sol to 1/0 str
PNL 4; 14 sol to 4 str
PNL 8; 14 sol to 8 str
On all sizes, tongue is NEMA standard.

Insulation butts flush, full circle—the PennLug's circular boss gives a snug fit and easier taping.

Annular serrations for higher conductivity and better resistance to horizontal pull—cable is snubbed behind the ridges.

More contact area with the conductor (up to 11% more) than conical, cylindrical or hexagonal bodies.

UL approved in all sizes.

No extra cost for these improvements—prices as attractive as the lugs. **Write for samples** of the sizes you are using.

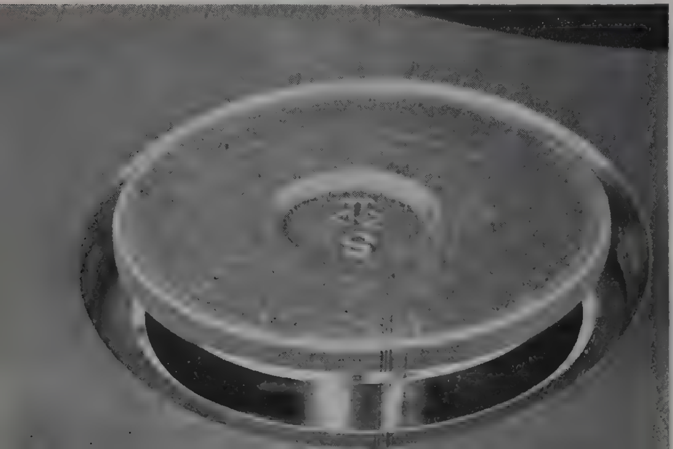
PENN-UNION ELECTRIC CORP., Erie, Pa.
Export Sales—Philips Export Co., 100 East 42nd St. New York 1, N.Y.

PENN-UNION *a good connection* **PENNLUGS** Sold by Leading Electrical Distributors

Beefed up for hardest

Construction jobs are rough on generators . . . but not as tough as Onan's own tests. That's why Onan plants mean reduced downtime and maintenance. Over-sized bearings, Stellite valves, shorter, stronger crankshafts and connecting rods keep Onan on the job when others can't take it. Put an Onan on the job along-side the plants you're now using. Your own records will prove Onan best.

Stellite coated exhaust valves and valve seats. One of toughest alloys known. Gives you up to 300% longer valve life than uncoated valves. It's the important details like this that make Onan more economical in the long run.



Exacting standards govern manufacture—years of specialized experience and extensive testing facilities control the quality of Onan Power Plants. Over 1000 different types and sizes of plants are produced by Onan.

use...even abuse

Onan electric plant still delivers full power after 12,197 hour test—equal to 487,888 miles

A grueling endurance test that lasted one year, nine months and 12 days could not stop Onan test plant #1068. Onan engineers used this production-built unit for an endurance run—and after it was all over, it still generated the full rated power promised on the nameplate. Proof that Onan's exacting standards and production testing give you a power plant with long, dependable life built in.

Over 1,700 other endurance units have been run by Onan engineers. In these tests every design feature and part has to prove itself before it can become a part of the Onan you buy. In addition, every type and size Onan plant is tested under all operating conditions which could conceivably affect performance on your job.

Hours of running in and testing under full load are given *every* Onan before it is shipped. An independent testing laboratory then spot tests Onan Plants that have already been tested by Onan—double assurance that every Onan will deliver its full nameplate rating. Only then does an Onan production run qualify for Performance Certification.

Buy *proven performance* when you buy an Electric Plant. See your authorized Onan distributor or dealer. You can depend on him for a lifetime of factory parts and service. He's listed in the Yellow Pages.

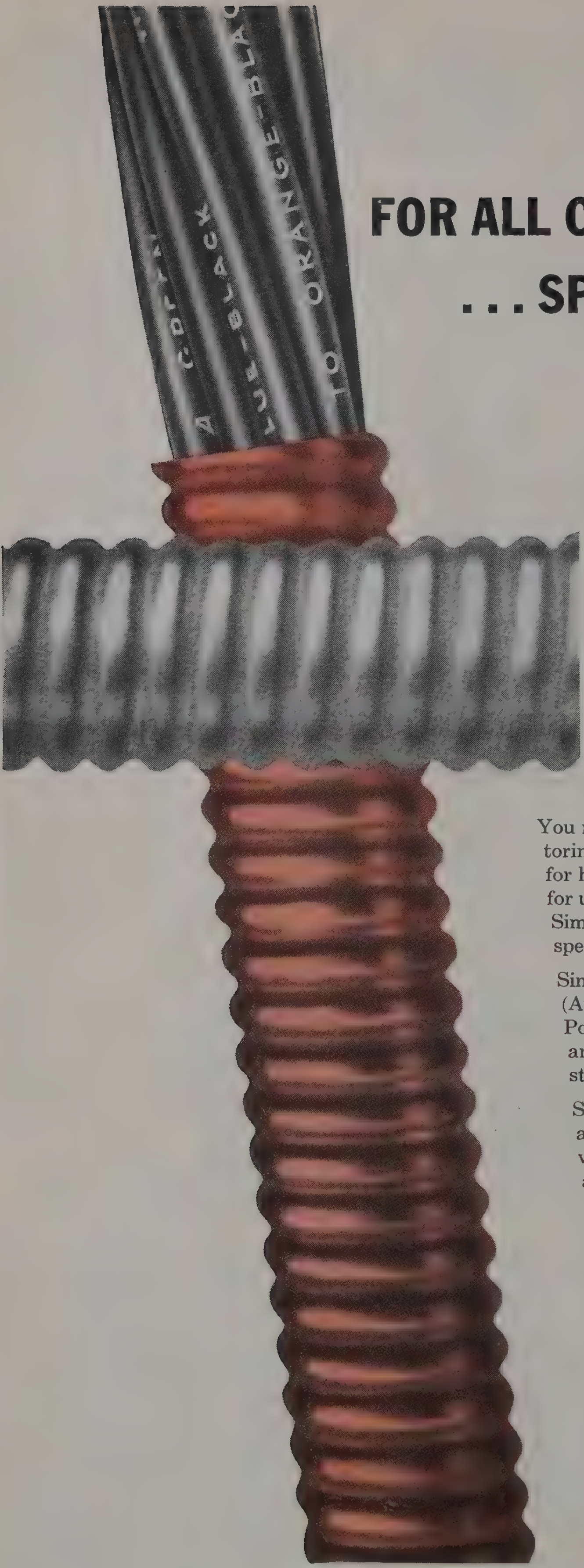
ONLY ONAN GIVES YOU THIS CERTIFICATION

PERFORMANCE CERTIFIED

We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.

World's Leading Builder of Electric Power Plants

ONAN DIVISION, STUDEBAKER-PACKARD CORPORATION • 2577 UNIVERSITY AVE. S. E., MINNEAPOLIS 14, MINNESOTA



FOR ALL CONTROL CABLE NEEDS
. . . SPECIFY SIMPLEX CABLE

RUBBER, PVC, SILICONE, POLYETHYLENE-NYLON, POLYETHYLENE-PVC, POLYETHYLENE, TEFLON

You name the requirement: supervisory cable for monitoring and/or recording; cable for protective devices, for heavy magnetic trip or break devices; control cable for use in conjunction with high voltage power circuits. Simplex will supply it . . . engineered precisely to specifications.

Simplex control cable insulations include rubber (Anhydrex, Anhydrex XX), PVC, Polyethylene, Polyethylene-Nylon, Polyethylene-PVC, Silicone and Teflon. And they meet all IPCEA-NEMA standards.

Simplex cables are available with copper, bronze, aluminum and steel C- L- X sheaths or with a variety of other jacketing materials. Also available are packaged combinations for power and control.

Simplex welcomes the opportunity of discussing individual control and power cable problems. Write today, giving details.

Simplex
WIRE & CABLE CO.
Cambridge, Mass. • Portsmouth, N. H.

NEW SYLVANIA-6146A

maintains 45W output* with battery supply as low as 5 Volts

New Sylvania-6883A (12.6V type), 6159A (26.5V type) deliver 45W power at reduced A-supply of 10V and 21V, respectively

From Sylvania comes the first major performance improvement to the popular 6146 and its counterparts since their introduction 7 years ago. The new Sylvania-originated 6146A, 6883A, 6159A eliminate communications fade-out caused by decreased heater voltage supplies. They're unilaterally interchangeable with their prototypes—offering the same output capabilities at normal heater ratings.

If heater voltage regulation is plaguing your mobile or airborne communications, replace with the modern 6146A, 6883A, 6159A by Sylvania. Your Sylvania Industrial Tube Distributor has them in stock, now. Call him for prompt delivery. If you need technical data, write Sylvania Electric Products Inc., Electronic Tubes Division, 1100 Main St., Buffalo 9, N.Y.

*Minimum output limit for an individual tube (CCS) measured in a single-tube self-excited oscillator circuit. Conditions: plate voltage—600Vdc; grid #2 voltage—180Vdc; grid #1 resistor—30,000 Ohms; plate current—100 to 112 mA; grid #1 current—2 to 2.5 mAdc; frequency—15 MC.

RF amplifier output, Class C service—70W (ICAS) up to 60 MC, 35W (ICAS) up to 175 MC.

Available from your Sylvania Industrial Tube Distributor

SYLVANIA

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GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

CONTROL

Now! Make any pushbutton station you want with new, completely versatile Cutler-Hammer oiltight pushbuttons

Choose from a complete line of operators, get greater circuit flexibility than with any other make

To meet today's need for a broad range of oiltight pushbuttons, Cutler-Hammer gives you a new versatile line.

You can get these rugged proved pushbuttons in one hole or base mounting, six bright colors. More than thirty different circuit arrangements are available plus hundreds of varieties of stations in standard arrangements of up to 25 elements. And you can get up to 8 circuits on one pushbutton. The flexible oil resistant diaphragm behind the button is designed to stay soft and pliable permanently.

With Cutler-Hammer pushbuttons you can get more control in less space, too, because they use 40% less behind the panel space than the next smallest unit.

Get all the facts by sending for the colorful brochure, "MASTER DESIGN" which tells you all about the Cutler-Hammer line. Ask for Pub. LO-104.

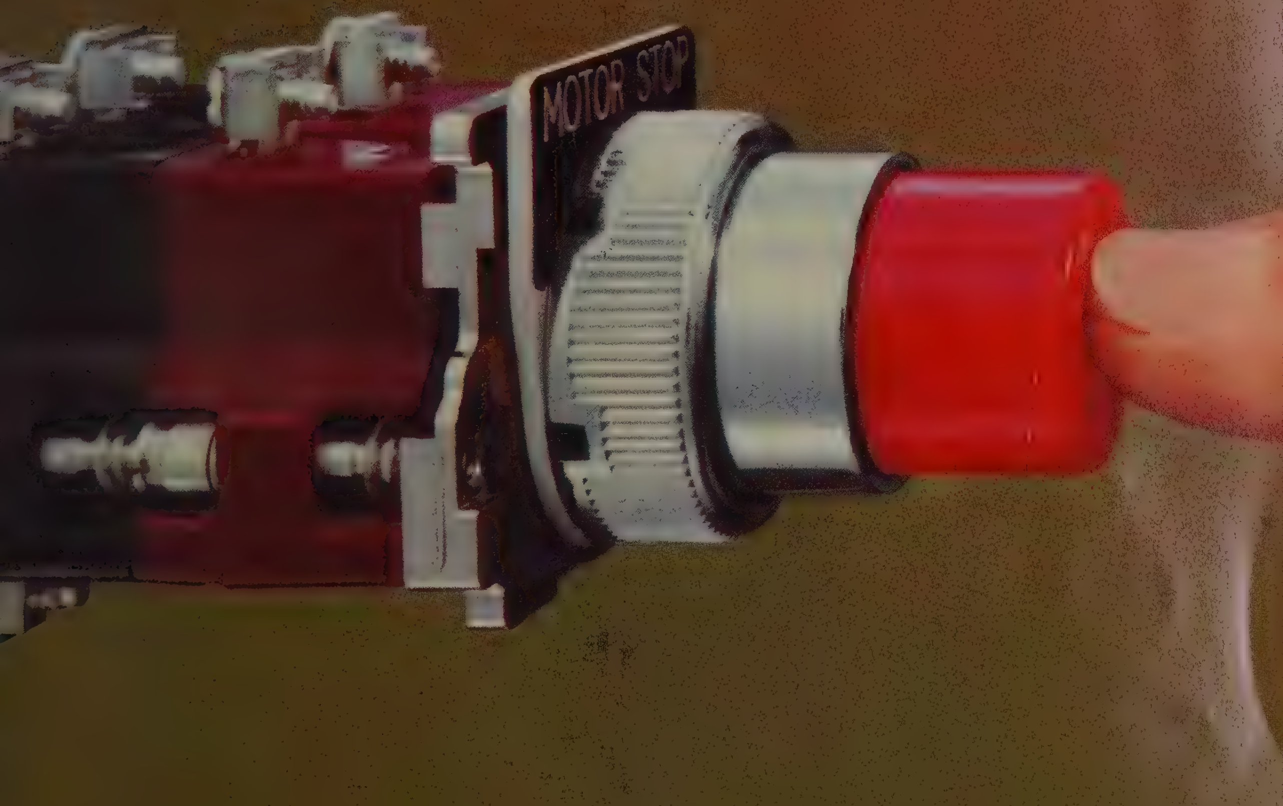
What's new at Cutler-Hammer? You can see the newness in the products coming from Cutler-Hammer, like the new smaller pushbuttons; in the new manufacturing facilities; in the new engineering ideas. All to give you better service today and in the future. Contact the nearest Cutler-Hammer sales office or your Cutler-Hammer distributor.

WHAT'S NEW? ASK...

CUTLER-HAMMER

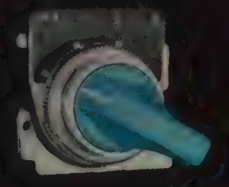
Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

CONTROL



NEW ILLUMINATED PUSHBUTTON. Newest addition to the versatile line.

YOU CAN GET ALL THESE TYPES OF CONTROL UNITS


LEVER

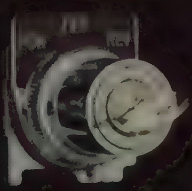
MUSHROOM

LONG

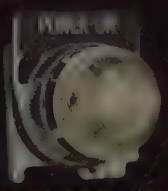
ROTO-PUSH

STANDARD

RESISTOR LIGHT



KEY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GUARDED

PRESTEST LIGHT

TWO HANDS
Can Make MORE PROFITS
With BRIEGEL
Indenter Tools and Fittings

There are but few products with which you can do a better job in less time at lower cost.

Used together, Original B-M Indenter Fittings and Tools will do just this and increase your profits from each installation.

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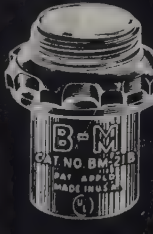
½" Offset Connector
BM-52
¾" Offset Connector

BM-41
½" Coupling
BM-42
¾" Coupling
BM-43
1" Coupling



Red Throat
BM-21B
½" Connector
BM-22B
¾" Connector
BM-23B
1" Connector

ALL BRIEGEL FITTINGS ARE U.L. APPROVED AS CONCRETE-TIGHT

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All B-M indenter type fittings far exceed the requirements of U. L. file card E 10863 and Federal Specifications W-F-406.

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USED THE MOST FROM COAST TO COAST

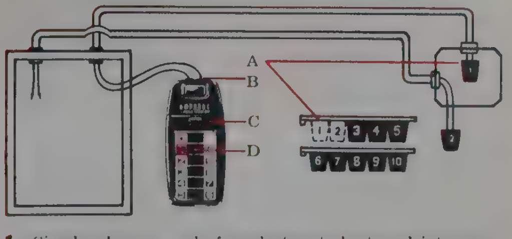
NOW... ONE MAN CAN TRACE CABLES FAST!

CABLE TRACER

Now you can trace conductors in cables and conduit– *10 times faster* than ever before–and leave your helper free to finish other jobs quickly and profitably. A tracing *system* in itself, revolutionary new CABLE TRACER lets you search–and *unmistakably identify*–up to 10 separate circuits simultaneously, even in the dark and when color coding is absent or obscured by age and dirt. It can also test for opens and shorts.

CABLE TRACER is a completely self-powered precision tool which forever eliminates the need for clumsy buzzers. Designed by the makers of famous AMPROBE snap-around test instruments, new CABLE TRACER is simplicity itself to use. At the press of a button, a number lights up to identify the conductor. What's more, CABLE TRACER will pay for itself in saved labor costs after only three jobs. It is supplied with three test leads and ten Station Blocks in a belt-looped carrying case made of top-grain cowhide leather. Test-try CABLE TRACER today; your AMPROBE Distributor has a live-action demonstrator. Or write for free Catalog Sheet CT-10.

only **$\$39^{50}$**



1. Simply plug one end of conductors to be traced into numbered Station Blocks (A).
2. Plug other ends into Receptacle (B) at top of CABLE TRACER.
3. Press Indicator Button (C).
4. The number on CABLE TRACER's Indicator Panel (D) corresponding to the Station Block at the other end of the conductor being traced (No. 1, in this case) *lights up* to provide identification–instantly, clearly, unmistakably! Using all the Station Blocks, ten conductors can be traced at one time.

PYRAMID INSTRUMENT CORPORATION, LYNBROOK, NEW YORK *Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto, Ont.*

ONLY ONE SNAP-AROUND TESTS ALL THREE!

AMPROBE RS-3

THE AMPROBE RS-3 is the *only* pocket-sized, snap-around test instrument that measures voltage, amperage *and* resistance. Designed for one-hand operation, the RS-3 accurately locates opens and shorts, sets overload relays, balances loads, determines low or high-voltage conditions…in fact, it handles up to 99% of *all* your test needs!

The rugged, lightweight AMPROBE RS-3 meets every commercial voltage requirement on three voltage scales: 0-150/300/600 volts AC. It also has five current ranges from 0 to 300 amps, and a resistance scale with a mid-range reading of 25 ohms. You take these readings from a *rotary* scale…it reveals only one range at a time to increase reading speed, minimize chance of error. The RS-3 comes complete with test leads, ohmmeter attachment, genuine cowhide leather carrying case, and a *one-year guarantee* against defects in parts or workmanship. See your distributor or write today for more details. **only $52.50**

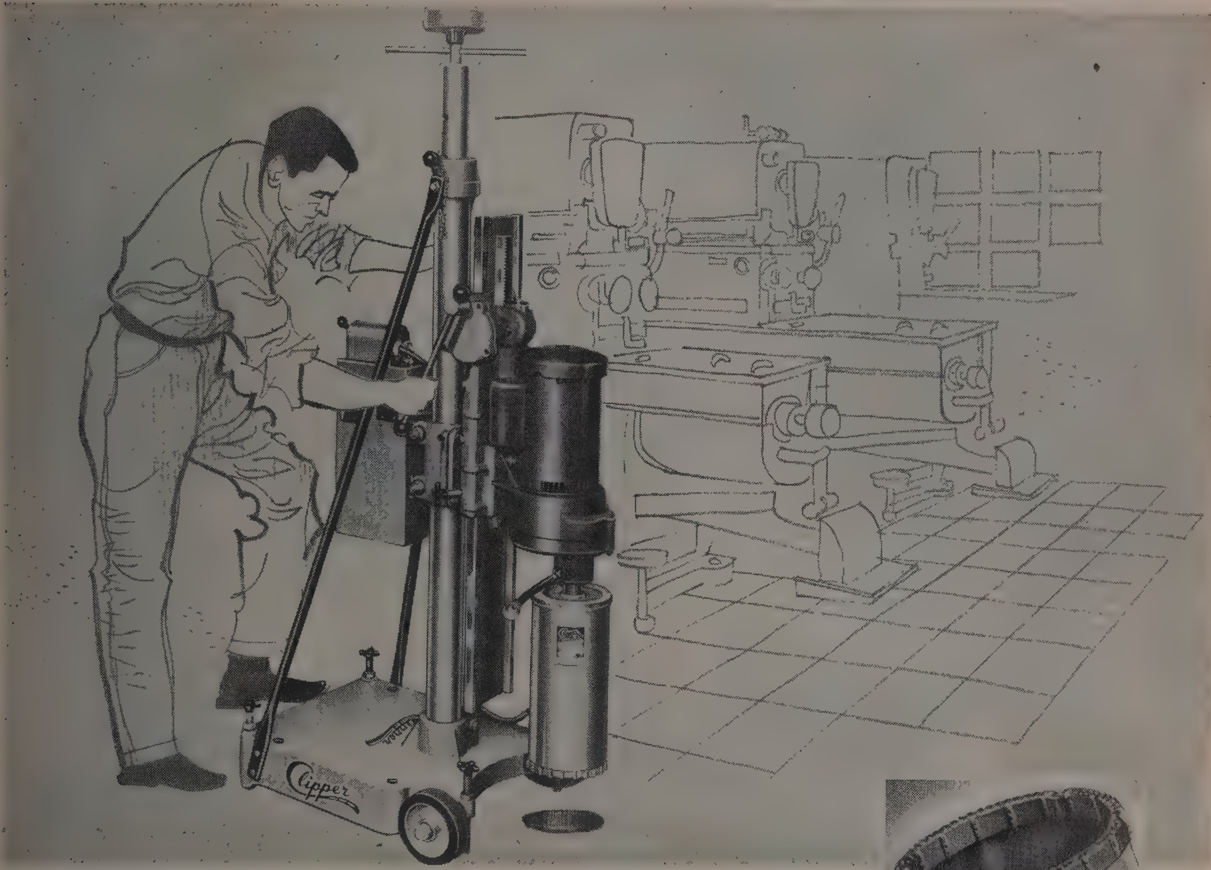
AS AN AMMETER: snapped around conductors to balance circuits.

AS AN OHMMETER: check r of motor control solenoid

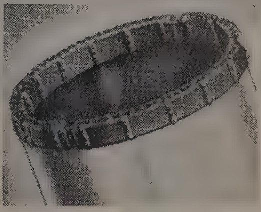
AS A VOLTMETER (large photo): check voltage on slipring of mot

PYRAMID INSTRUMENT CORPORATION, LYNBROOK, NEW YORK *Canada: Atlas Radio Corp., 50 Wingold Ave., Toront*

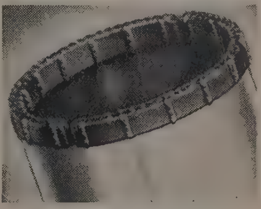
CLIPPER guarantees its core drills to out-perform all others



Holes Up to 14″ in Concrete in Minutes



ORIENTED SURFACE SET RESETTABLE BITS give maximum bit life in the hardest reinforced concrete.



SURFACE SET "THROW-A-WAY" BITS — Combine drilling speed of resettable bit with convenience of "throw-a-way" bits.

When you buy a Clipper Core Drill you know you're buying the world's only core drill guaranteed to provide completely successful drilling. No matter how tough the drilling job, the speed of a Clipper drill remains constant, assuring faster drilling and longer bit life. In minutes, a Clipper will drill holes up to 14″ in diameter through reinforced concrete, asphalt, masonry, stone and refractory products.

POWER—Equipped with specially designed G.E. induction type motors, Clipper Core Drills give maximum power . . . are lifetime lubricated . . . have no brushes to wear out . . . have heavy duty hardened steel gears and anti-friction bearings.

CONSTANT SPEED—Under any load, the speed of a Clipper core drill remains constant. And most important, you get a choice of speeds—300, 800 and 1500 R.P.M.—to fit the size bit for the job you are doing. Only Clipper offers all these extras for more effective drilling and longer bit life. Don't be misled . . . adequate power and proper constant speed are essential for fast, economical drilling . . . and are not available in ordinary units using converted hand drill motors.

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Complete product information is yours for the asking.
Check the product brochure(s) desired:
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☐ Clipper Masonry and Concrete Saws for all masonry, concrete and asphalt cutting

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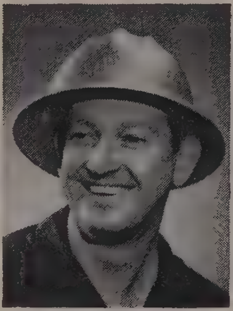

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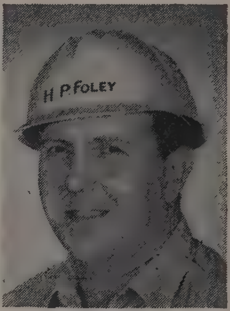

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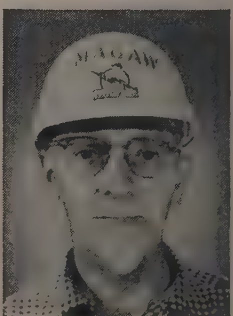

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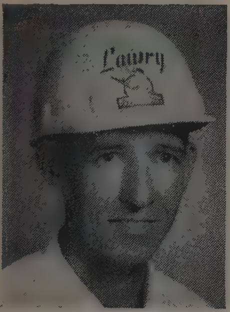
Field Men say...



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"They're OK if they're O.Z."

For over 40 years top Field Superintendents, Engineers, and Project Managers of the nation's leading electrical contracting firms have specified O.Z. electrical fittings.

Their experience and background has taught them to rely on O.Z.'s complete product line and superior quality. They know O.Z.'s broad distributor program means they get the right fittings—at the right time—at the right place.

On your next job—big or small—take a tip from the top. Get the best quality and widest choice at competitive prices. Specify O.Z. fittings all the way and you too will say, **"They're OK if they're O.Z."**

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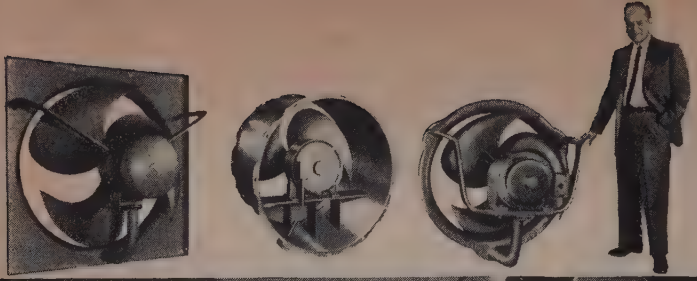
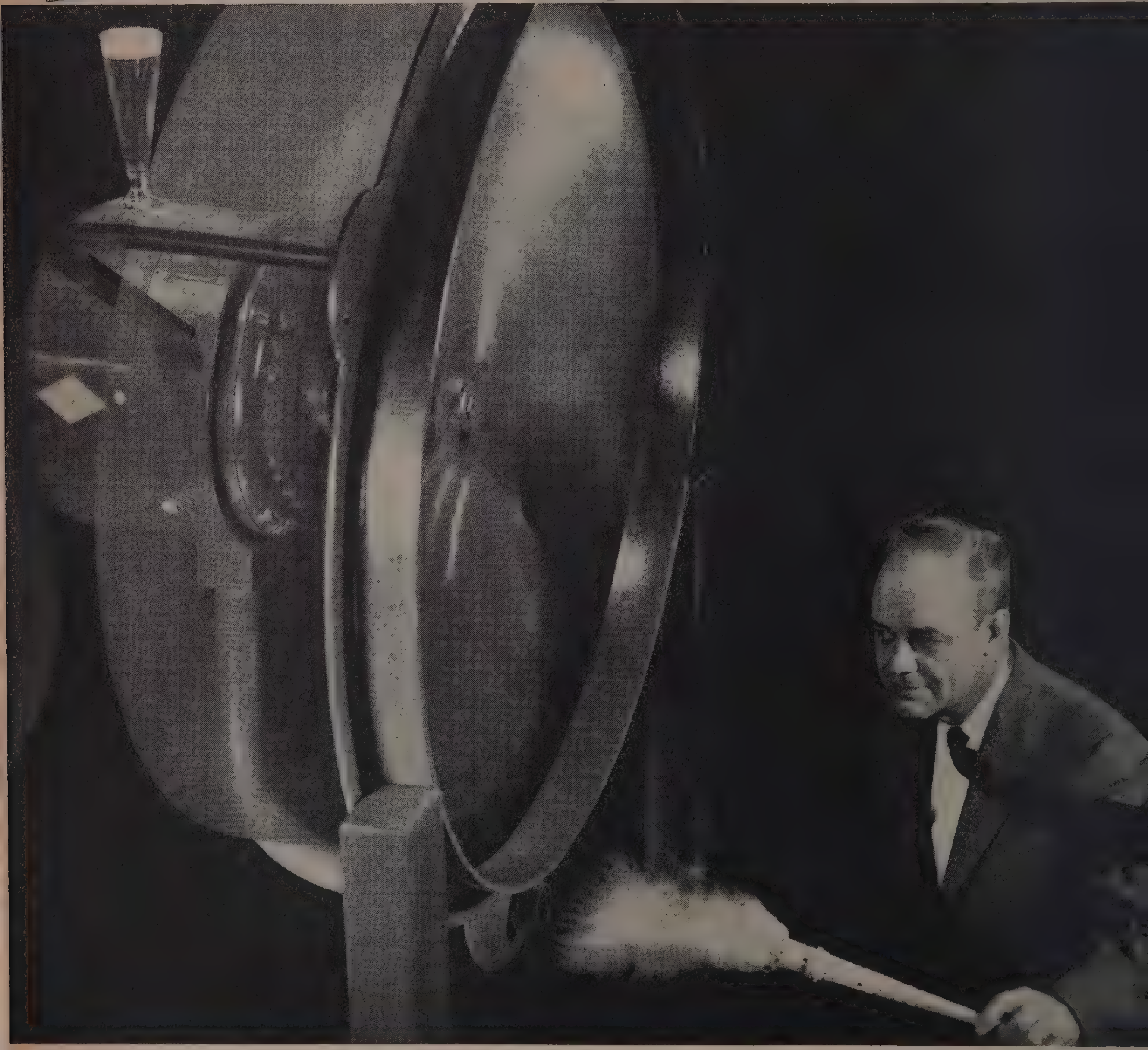
- INTERLOCKED ARMOR CABLE FITTINGS



Name Your Choice. For every propeller fan need, Ilg has the answer. Shown here: (left) Ilg Type PF square panel fans with direct-connected, self-cooled motor; (center) Ilg Type TAQ direct-connected tubeaxial duct fans; (right) Ilg Type XQ direct-connected, explosion-proof models for hazardous applications.



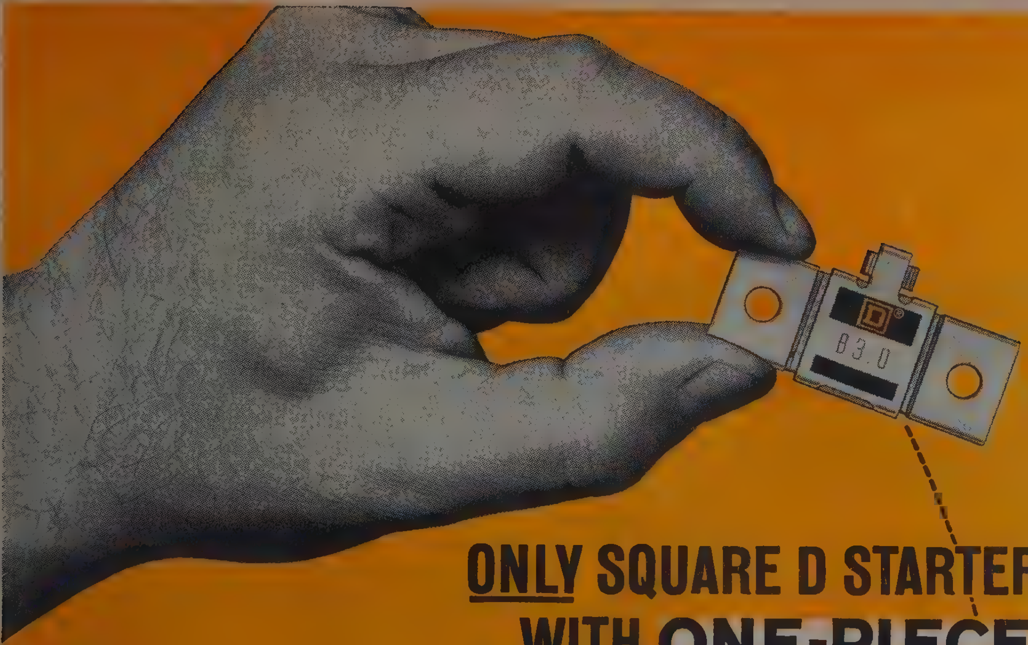
HERE'S WHY ILG FANS RUN COOL AND QUIET

See how the vent pipe on this Ilg propeller fan sucks in outside air . . . pressure-cools the permanently lubricated, direct-connected Ilg motor. Ilg's famous self-cooling feature provides the protection of motor enclosure, the operating economy of open types, and keeps motors clean *inside and out.*

And with dynamic balancing of all component parts . . . electronic checking of Ilg motors and wheels before and after assembly . . . you can be sure Ilg self-cooled fans run so quietly, so smoothly you can balance a glass of beer on the motor, *while the fan runs,* and find no bubbles due to vibration. For further information, write for Bulletin DB1-100.

ILG ELECTRIC VENTILATING CO

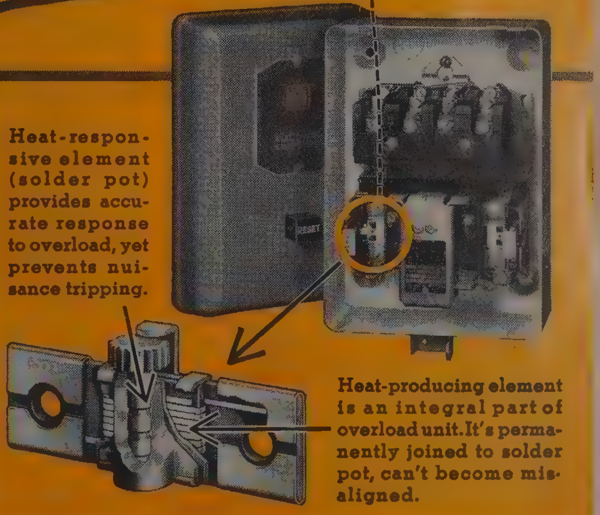
2879 N. Pulaski Road, Chicago 41, Ill.
Offices in 60 Principal Cities
Member of Air Moving and Conditioning Association, Inc. (AMCA)



ONLY SQUARE D STARTERS WITH ONE-PIECE OVERLOAD RELAYS GIVE *Absolute* PROTECTION!

• Only Square D makes thermal overload relays with 1-piece construction—and only with 1-piece construction can you *know* you've installed the heater correctly. Square D 1-piece overload relays can be installed only one way. They are factory-assembled, individually tested and calibrated, completely tamper-proof. Repeated tripping will not affect accuracy.

You *pay* for overload protection—be sure you *get* it. Insist on Square D 1-piece overload relays for *absolute* protection.

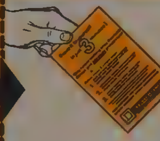


Heat-responsive element (solder pot) provides accurate response to overload, yet prevents nuisance tripping.

Heat-producing element is an integral part of overload unit. It's permanently joined to solder pot, can't become misaligned.

EXCLUSIVE—
1-piece Overload Relay
for *ABSOLUTE* Protection!

Mail coupon today for simple "jig-saw" demonstrator—see why only Square D gives absolute protection



Square D Company
Department SA-222
4041 North Richards Street
Milwaukee 12, Wisconsin

Please send me information on Square D magnetic starters, along with your simple 3-minute "jig-saw" demonstrator

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COMPANY________________________________

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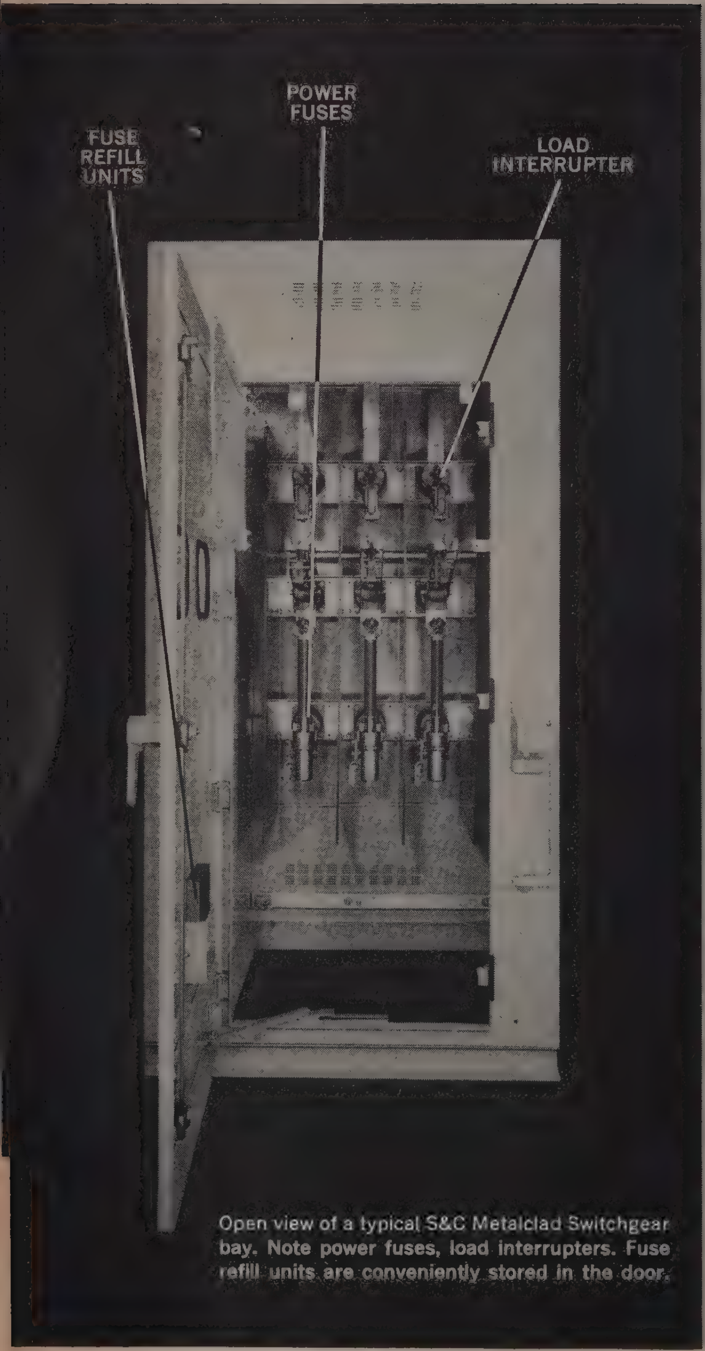
SQUARE D COMPANY

wherever electricity is distributed and controlled

Reclosing is for the birds



Open view of a typical S&C Metalclad Switchgear bay. Note power fuses, load interrupters. Fuse refill units are conveniently stored in the door.

So why buy this feature in your 2.4 thru 14.4-kv switchgear?

Reclosing is for the birds, squirrels, tree limbs, lightning, icing, windstorms, and kite strings that frequently cause non-persistent faults on open distribution lines of utility systems. Reclosing re-energizes the lines to restore service in a fraction of a minute.

But when faults occur on the enclosed power supply circuits of industrial plants, commercial and institutional buildings, you don't want to reclose on them. These faults—while extremely rare—are permanent. Someone has to locate the trouble and repair the equipment or cable—or at least isolate it—before the system can be re-energized. So why buy expensive circuit breaker type switchgear with its automatic reclosing feature?

S&C Metalclad Switchgear—employing fused load interrupters—gives the ideal protection for enclosed power supply circuits. Power fuses furnish the fault protection (load interrupters switch the load). After a fault occurs, you simply replace the inexpensive fuse refill unit (typically costing $13.50) while the fault is being located and corrected.

The economics all say, "Reclosing is for the birds." Why pay for a function you can't use?

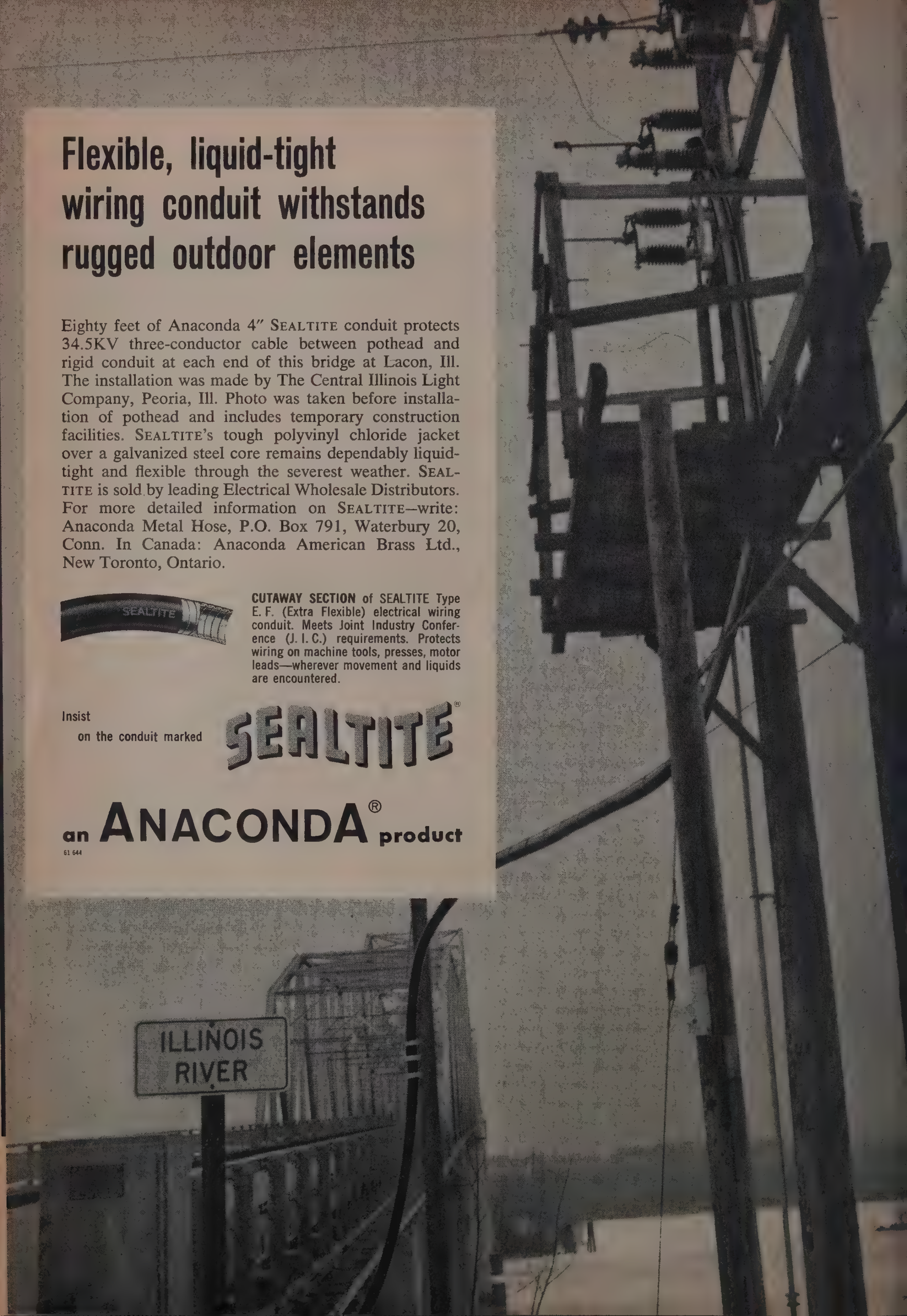
Cut your high-voltage switchgear costs in half by specifying S&C Metalclad Switchgear for your 2.4 thru 14.4-kv switching centers, service entrances, substation primaries and secondaries. Get full-load switching to 1200 amperes and fault interrupting to 500,000 kva.

See the Yellow Pages (Electrical Equipment) for your nearest S&C sales engineer. Or write to:

S&C Metalclad Switchgear meets all NEC requirements for fault-closing, short-circuit interruption. Performance proved by high-power testing at KEMA laboratories.

S&C ELECTRIC COMPANY
4433 Ravenswood Avenue • Chicago 40, Illinois
Specialists in High Voltage Circuit Interruption since 1911

The equipment is an S&C Metalclad Switchgear Assembly rated 13.8 kv, for a switching center.
The bird, a green-winged macaw, is an optional extra, obtainable at your local petshop.



Flexible, liquid-tight wiring conduit withstands rugged outdoor elements

Eighty feet of Anaconda 4″ SEALTITE conduit protects 34.5KV three-conductor cable between pothead and rigid conduit at each end of this bridge at Lacon, Ill. The installation was made by The Central Illinois Light Company, Peoria, Ill. Photo was taken before installation of pothead and includes temporary construction facilities. SEALTITE's tough polyvinyl chloride jacket over a galvanized steel core remains dependably liquid-tight and flexible through the severest weather. SEALTITE is sold by leading Electrical Wholesale Distributors. For more detailed information on SEALTITE—write: Anaconda Metal Hose, P.O. Box 791, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

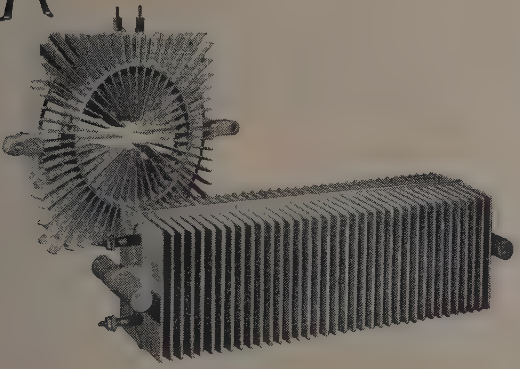
CUTAWAY SECTION of SEALTITE Type E. F. (Extra Flexible) electrical wiring conduit. Meets Joint Industry Conference (J. I. C.) requirements. Protects wiring on machine tools, presses, motor leads—wherever movement and liquids are encountered.

Insist
on the conduit marked **SEALTITE**®

an ANACONDA® product

61 644

SAFETY GRID ...one big reason why Electromode meets your heating needs best



This is the cast-aluminum Safety Grid that places Electromode electric heaters among the world's best performers. It makes Electromode an unusual heating value.

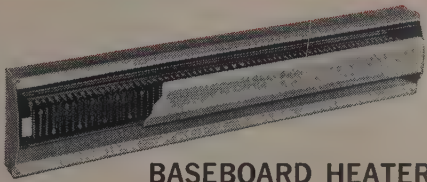
It's extremely efficient. It can maintain high heat output at a low surface temperature because of its large heating surface.

It's safe. A built-in safety switch automatically prevents overheating and cuts heater off if anything should interfere with normal operation.

It's an added value you'll find in all of the Electromode heaters shown here except the Quartzone heater and the explosion-proof heater.

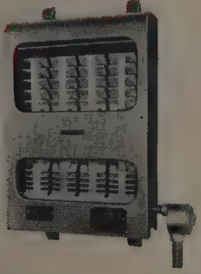
SUSPENSION HEATER

Installs easily—no plumbing or duct work necessary. Capacities from 5,122 to 153,675 BTU. 120, 208, 240 or 480 volts.



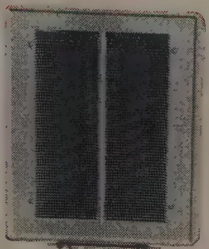
BASEBOARD HEATER

Lengths of 32", 64", and 96" for easy installation, flexible arrangement. Matching fittings. Golden-bronze finish. 120, 208 or 240 volts.



EXPLOSION-PROOF HEATER

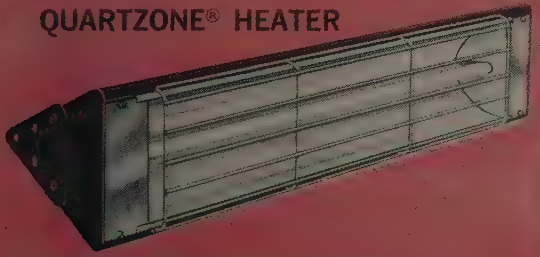
• Outputs of 3,413 to 20,490 BTU for hazardous atmosphere. Also panel model of 1,706 BTU for ethyl ether vapor atmosphere. 120, 208, 240 or 480 volts.



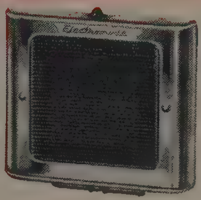
DOWN-FLO HEATER

Built-in wall heater. Thermostat, fan delay switch, down-flo principle. Golden-bronze finish. 5,122 to 13,660 BTU. 120, 208 or 240 volts.

QUARTZONE® HEATER



Infrared rays heat persons and objects, not just air. Removable aluminum reflector. 750, 1000, 1500, 2000, 3000 or 4000 watts. 120, 208, 240 or 480 volts.



BATHROOM HEATER

Easily installed. Automatic or switch operated. Safety Grid protects against shock or burn. 4,507 or 5,122 BTU. 110, 208 or 240 volts.

● FOR DETAILED INFORMATION, PRICES, AND INSTALLATION INSTRUCTIONS, WRITE:

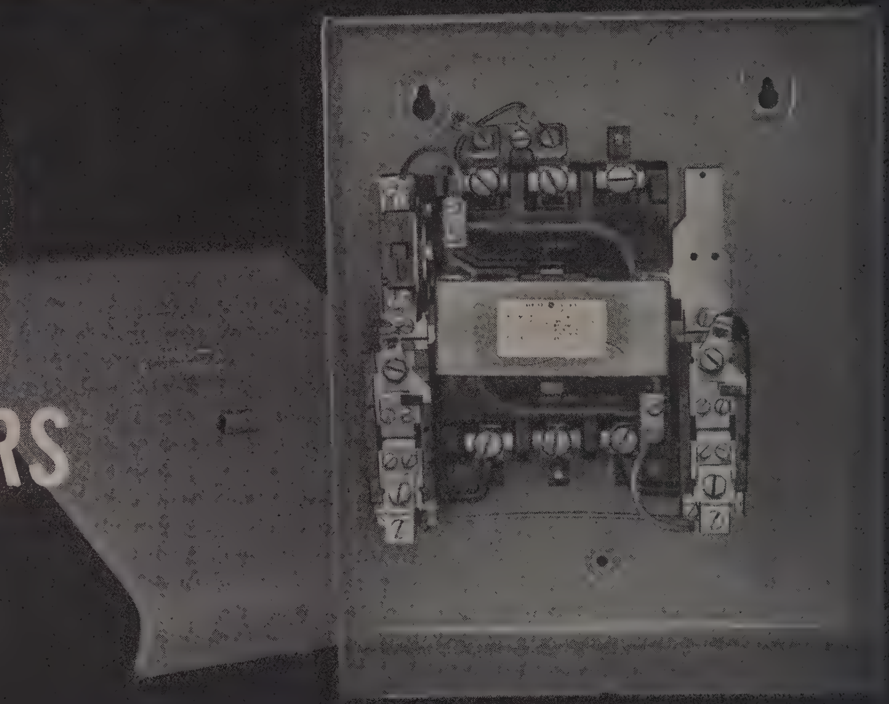
Dept. ECM-71

®Electromode

DIVISION OF COMMERCIAL CONTROLS
CORPORATION, 570 CULVER ROAD, ROCHESTER 3, N. Y.

From General Electric . . .

NEW
NEMA SIZE 3
NEMA SIZE 4
STARTERS



SIZE 3

SIZE 4

Field-proved 100-Line design—now available in Sizes 00 through 4—offers you unmatched savings in maintenance time and dollars.

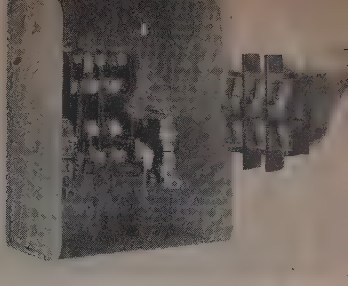
Inspect Contacts, Change Coil Without Tools Even on Size 4!

Imagine how much maintenance time and expense you can save with these new General Electric 100-Line starters! Without using even a screwdriver, you can inspect contacts in *10 seconds,* change coil in *20 seconds.* This is convenience no other starter can offer.

These new 100-Line Sizes 3 and 4 starters also give you the benefits of a design *field-proved* on over one million applications:

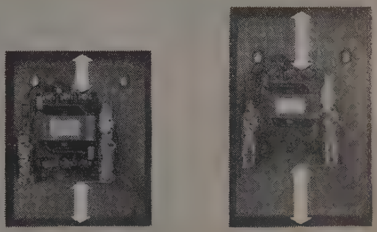
- Straight-through wiring saves hook-up time. All line terminals are on top, all load terminals on bottom.
- Pressure-type terminals accept wire through size 1/0 on Size 3 and 250 MCM cable on Size 4.
- Durable molded Strongbox coil resists dirt, moisture, oil, and mechanical damage.
- Slanted contacts shrug off dust and other contaminants.
- Wedge-action contacts close at an angle to reduce bounce and resultant arcing and pitting.

New General Electric 100-Line Sizes 3 and 4 starters are now available, enclosed or open, in all popular forms. Call your G-E sales engineer or distributor. Or, write for new publication GEA-7326, to Section 813-36, General Electric Co., Schenectady 5, New York.

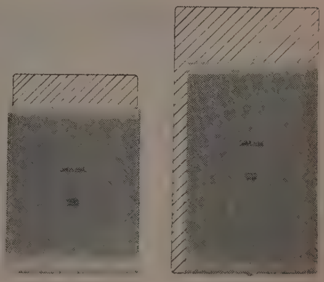


Inspect all contacts in 10 seconds without tools. Simply lift off spring-loaded retainers on upper right and lower left of coil. Entire movable assembly—including contacts, magnet, and coil—slides out for inspection. Both stationary and movable contacts are visible.

Change coil in only 20 seconds without tools. Lift off the two coil retainers and slide out movable contacts, magnet, and coil assembly. Remove spring-clip in "I" magnet and take off "I" magnet. Molded Strongbox coil can now be lifted off the "E" magnet.



You get plenty of wiring room. Enclosures on these new starters give you 3¼ inches of wiring space at top and bottom on Size 3; 5½ inches top and bottom on Size 4. All line terminals are at top, load terminals at bottom for easy hook-up.

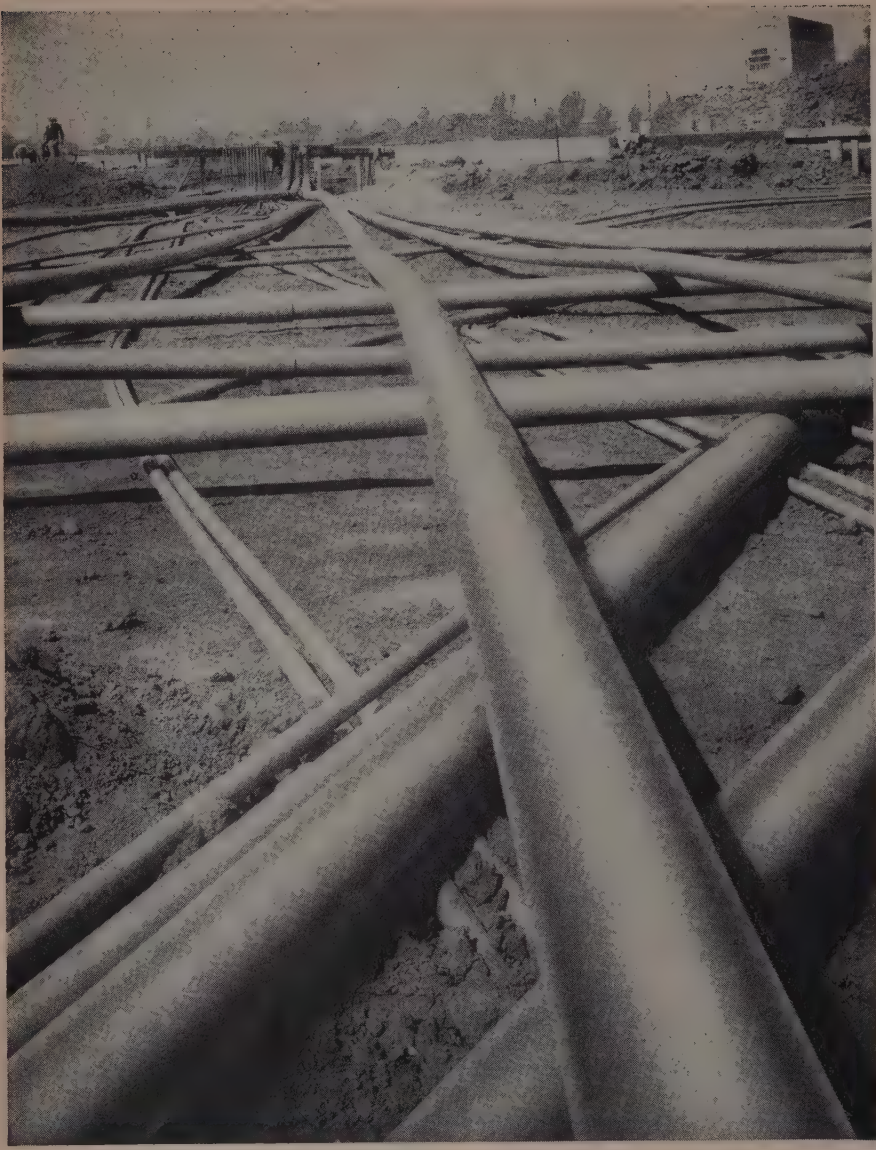


Significantly smaller than previous forms. New enclosed 100-Line starters are 9% to 23% smaller in area, fit where others won't. Size 3 enclosure is only 15⅛ inches high, 12⅛ inches wide, 7⅞ inches deep. Size 4 is 20⅛ x 12⅛ x 7⅞ inches. (Depth dimensions include reset button.) Compare with other makes.

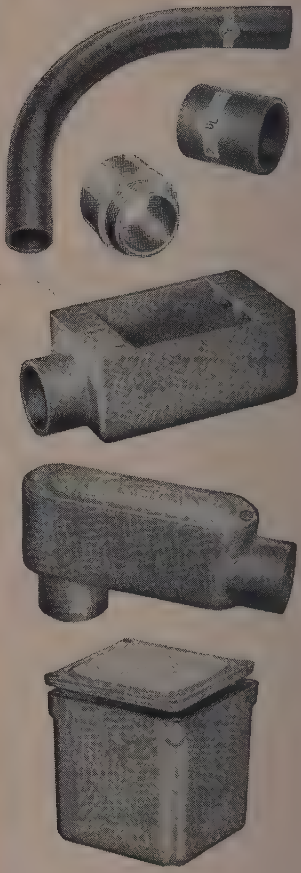
You Get **MEASURABLE ADVANTAGES**
WITH GENERAL ELECTRIC CONTROL

Progress Is Our Most Important Product

GENERAL ELECTRIC



B.F.Goodrich



This conduit is Kraloy Rigid PVC Conduit manufactured of Geon by Kraloy Plastic Pipe Company, Santa Ana, California. Like the conduit, fittings are unplasticized PVC. B.F.Goodrich Chemical Company supplies the rigid Geon vinyl.

Conduit made of rigid Geon gets UL-approval for underground service

The manufacturer of this conduit has obtained Underwriters' Laboratory approval for underground installations. Conduit of Geon vinyl is ideal for such applications, since it follows ground contours without costly grading. Rigid vinyl conduit has plenty of impact resistance to take earth or other shocks and is easy to handle and install.

Geon makes the conduit resistant to corrosive soil conditions—it is not affected by concrete, in which it will often be buried. No coating is needed. It is not subject to electrolytic action.

The installation story is even better. Weight is cut to half that of lightest-weight metal. Solvent welding can eliminate threading. Joints are permanent, clean, waterproof. Wire pulling is far easier because inner walls are extra smooth, and stay that way.

Vinyl won't support combustion and is non-sparking—these are more of the reasons Geon helps this manufacturer explore new applications. Rigid Geon makes excellent pipe, too. For more facts, write Department NQ-5, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

Geon
VINYLS

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

installation
time cut
52%

WITH

BENJAMIN

SHALLOW-LINE

TROFFERS

On job after job Benjamin Shallow-Line troffers have effected tremendous savings in installation cost: reducing installation time as much as 52%. Examine the many labor-saving features shown here such as the exclusive swivel-bar mechanism which eliminates cumbersome overhead yokes and the necessity to line-up housings with yokes.

Benjamin has the one line with a complete choice of lamp types and diffusers.
5 basic sizes: 1′ x 4′, 2′ x 4′, 2′ x 8′, 1′ x 8′ and 2′ x 2′.

1. swivel bar:
Quick adjustment can be made to align troffers in seconds with either hand or power screw driver.

2. drop-in-hinge:
No screws to tighten . . . no adjustment required. Installs on either side of housing.

3. tab-lock latch:
No tools required for permanent rattle-free fastening.

BONUS FEATURES

SNAP-IN SOCKET plate one-piece assembly snaps in or out without aid of tools.

FUSED FOR SAFETY: cartridge fuses protect equipment against overload.

ONLY 4⅞″ DEEP for greater structural freedom between floors.

ONE PIECE HOUSING for added strength . . . no sections to fit together eliminates extra labor costs.

ALL THESE EXCLUSIVE FEATURES
PLUS FAMOUS BENJAMIN CRAFTSMANSHIP
ARE WHY THERE ARE MORE SATISFIED CUSTOMERS
WITH SHALLOW-LINE TROFFERS

THOMAS INDUSTRIES INC.
BENJAMIN DIVISION
207 East Broadway, Louisville 2, Kentucky
The World's Largest Single Source of Lighting for Commerce, Industry and Home.

THOMAS INDUSTRIES IN
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207 E. Broadway, Louisville 2, Ky.

☐ Please send me complete information on Shallow-Line Troffers.

☐ Please have your Lighting Engineer call.

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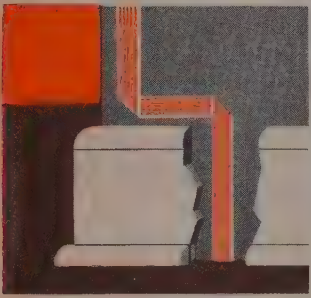
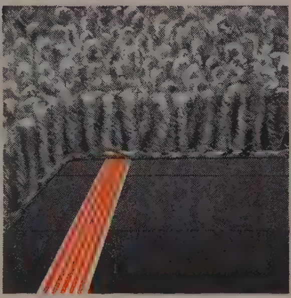
In ELECTRONIC COMPONENTS If it's news, expect it first from IRC

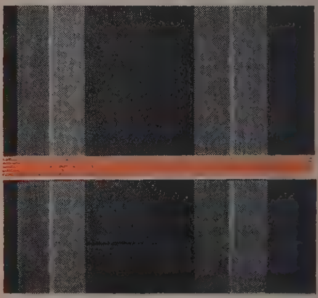


Installs behind surbases



Lies under floor coverings

Conceals easily behind wallpaper



Saves drilling in walls and wood

Use POLYSTRIP®...the new, easier way to make low-voltage interconnections

Users find POLYSTRIP a time, money, and headache-saver. The speed of installing this flat cable results in substantial savings. POLYSTRIP lies under floor coverings without causing bulges; slips between wallboard seams, behind moldings, through openings, thus eliminating drilling or cutting walls and woodwork. It fastens to finished walls, ceilings and baseboards with double-backed tape, doing away with conduit and plaster-cracking hardware. The many features of this new concept in cabling make POLYSTRIP equally valuable for new-construction or renovation.

POLYSTRIP consists of uniformly spaced flat copper conductors laminated with transparent plastics into a very thin, flexible, flat cable. Already proved in industrial electronics, it is now applicable for hi-fi, paging, signalling and alarm systems, programming, wired remote TV control.

INSTALLER'S KIT SAVES 47%

Assortment #205 saves 47% over the separate prices of items it includes. Contains 75-foot rolls of both 3- and 5-conductor cable; 6 splicing and 2 wire lead type connectors* for both 3- and 5-conductor cable; 50-foot roll of double-backed adhesive tape and 1 Stripping Tool.

International Resistance Company, 414 North 13th Street, Philadelphia 8, Pa.

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*POS-E-FLEX Connectors by The Thomas & Betts Co., Inc., Elizabeth 1, N.J.

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Leading supplier to manufacturers of electronic equipment

60TH YEAR • JULY 1961

ELECTRICAL CONSTRUCTION AND MAINTENANCE

Apparatus Service Looks Ahead

From the shop-talk around the convention of the Electrical Apparatus Service Association (formerly NISA) in San Francisco last month, it is clear that the apparatus service segment of the electrical industry is growing vigorously in an expanding market. In spite of the chronic cost-price squeeze, the shops are forging ahead with better tooling, advancing technology and a broader range of customer services.

The key role of the electric apparatus service establishment in our highly mechanized economy is rarely appreciated. The excellent, highly-skilled, service facilities promptly available in almost every community is usually taken for granted. Yet without it much of our complex industrial electrification would be impractical, troublesome and excessively costly. Original manufacturing can build in only so much reliability, it must eventually be complemented with competent, readily available, efficient service at a reasonable cost.

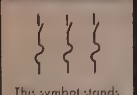
Rooted in motor repairs, the apparatus service industry has steadily broadened its activities to include many other types of electrical equipment. Current expansion involves highly specialized facilities for handling hermetic compressors—a field with almost unlimited potential—and the new and increasingly sophisticated automatic control installations. In the latter case, particularly, the availability of highly qualified personnel, locally situated and backed up by full shop and technical facilities, can have a decisive effect on the market acceptance of such apparatus.

Many leading manufacturers have had notable success with delegating "authorized service" operation to independent electrical service establishments. It is testimony to the vigorous integrity and competence of these shops that they perform so effectively in situations in which the reputation of the manufacturer's product is often at stake.

In the long history of electrical evolution each new development tends to inspire some new notion for handling service and maintenance. In most cases, however, the apparatus service shops quickly rise to the challenge and are soon set up to handle new equipment routinely and with characteristic efficiency and economy. The growing energy and versatility of electrical apparatus service shops across the country is a healthy phenomenon and a good omen for the future of the electrical industry and the customers it serves.

Wm. T. Stuart

KNOW YOUR SYMBOLS



This symbol stands for fusible switch

This symbol stands for QUALITY

THE SAFETY SWITCH THAT CHALLENGES COMPARISON . . .

BullDog's general-duty safety switch!

- Minimum arcing—double break switching
- Arc control—Vacu-Break® principle
- Pressure contacts—Clampmatic® spring action
- Positive switching—direct handle operation
- Front operation—permits ganging

. . . plus, all current-carrying parts are silvered. Available in NEMA 1 and NEMA 3R enclosures . . . competitively priced. Challenge our distributors to prove these switches are the finest. Write for details!

BullDog Electric Products Division, I-T-E Circuit Breaker Company, Box 177, Detroit 32, Michigan. In Canada: 80 Clayson Rd., Toronto, Ont. Export Division: 13 East 40th St., New York 16, N. Y.

I-T-E CIRCUIT BREAKER COMPANY
BULLDOG ELECTRIC PRODUCTS DIVISION

AN APPLICATION MANUAL ON . . .

MODERN ELECTRIC CONTROLS

By J. F. McPartland

Ready-reference data on equipment and techniques for electric control of power, lighting and heating loads, pointing up National Electrical Code requirements and covering—

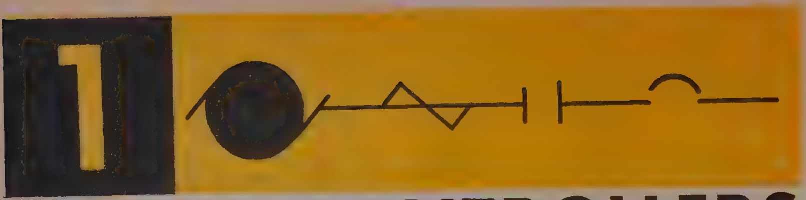
Operation of control equipment •
Selection of proper sizes and ratings, and •
Layout and installation of circuits •

THIS is the age of electric control. Long obscured by spectacular developments in the field of electric power, the technology of control has only recently asserted its basic significance. With incredible growth in consumption of electric energy in industry and commerce and with accelerated expansion in capacity of electric power generation and transmission, control is the key to the future of the electrical industry.

Through the years, control equipment and circuits have been integral parts of construction for electric energy distribution and utilization. In one or more forms, every electrical circuit for light or power has its control elements. To electrical contractors, consulting electrical engineers, plant electrical personnel and electrical inspectors, therefore, increase in amount and complexity of electric control demands only an intensification of their efforts in an area in which they have long performed well. They must learn the methods and equipment used in modern control; they must develop necessary installation procedures and techniques; they must provide the bridge over which control theory and equipment can pass to installed, operating systems. Their job is big; their role, important.

The article presented here has been prepared as a basic manual on electric control for the electrical construction and maintenance industry. The presentation is aimed at practical application—the selection of proper types and sizes of equipment to perform control functions as required by the controlled equipment and prevailing conditions. The material covers: motor circuits and equipment, control circuits, contactors and relays, control switches and application of control to lighting and power loads.

Of course, there are many other devices and systems of equipment which find specific control applications in modern industrial plants. These include a very wide range of special sensing and measuring devices and regulating and switching components for systems accomplishing high degrees of automatic machine operation. Such applications, however, involve highly specific engineering and are, therefore, beyond the scope of this article.



MOTOR CONTROLLERS

CONTROLLERS for electric motors cover a wide range of types and sizes to meet the varying characteristics of motor applications. Depending upon the type, size and application of a motor to be controlled and the characteristics of the driven load, a motor controller may be simple or complex:

- This controller may be manually operated or actuated by electromagnetic means.
- If magnetically operated, there are two basic ways in which the control action might be initiated—manually or automatically. For instance, a pushbutton or selector switch might be used to manually initiate magnetic operation of the controller. Or a limit switch or float switch might be connected to the controller to provide automatic initiation of magnetic operation of the controller in response to conditions of the load.
- In many cases, the size of the motor and the torque requirements of the load may require provisions in the controller to start the controlled motor with voltage lower than that supplied by the line, to limit starting current, thereby reducing voltage disturbances in the system.
- In still other applications, the motor controller may have to provide control of the speed of motor rotation or of the direction of rotation.
- Further, the difference between ac and dc motors and the use of high-voltage motor circuits also contribute to the extensive variety of construction and operating characteristics of motor controllers.

From the foregoing, it is obvious that selection of controllers for particular motor applications involves a series of determinations based upon control objectives and thorough understanding of controller operating characteristics. And when a controller has been selected to accomplish desired operation of the motor, the equipment must be integrated into the over-all control plan. The controller must be provided with any necessary pilot devices and a wiring layout must be made to interconnect them. And if the equipment is used in a hazardous location or where adverse atmospheric conditions prevail, the proper types of enclosures must be used.

In modern electrical distribution systems, supplying ever-expanding concentrations of motor loads, selection of proper motor controllers, pilot devices and control circuits can go a long way toward assuring maximum effective utilization of system capacity. In far too many systems, ineffective control of large, widespread concentrations of motors operating on varying schedules and duty cycles and drawing heavy peaks of starting current is responsible for severe voltage disturbances which adversely affect operation of all loads on the system and the system equipment itself. Motor control, as an engineering consideration, should therefore involve not only the relation between the control equipment and the controlled motor load but also the relation between the load and the supply system.

Code Rules on Motor Circuits

Although effective application of motor controllers is based primarily on thorough engineering analysis, careful consideration should also be given to the National Electrical Code which sets forth minimum safety provisions for the control of motors.

Adherence to code requirements will provide control hookups which are essentially safe, but not necessarily efficient, convenient or flexible. In no way is the code a substitute for intelligent design of motor control circuits suited to the particular characteristics of each individual application. However, because the code does represent the accumulation of years and years of experience with motor circuits, it presents an excellent general outline of motor circuit design. Within this basic framework, the designer can add specific equipment features and circuit techniques to meet his needs.

Fig. 1 shows the five basic elements which the code requires the designer to account for in any motor circuit. Although these elements are shown separately here, there are certain cases where the code will permit a single device to serve more than one function. For instance, in some cases, one switch can serve as both disconnecting means and controller. In other cases, short-circuit protection and overload protection can be combined. In the letter order shown in Fig. 1, basic code requirements on these elements are as follows:

A—CONTROLLER

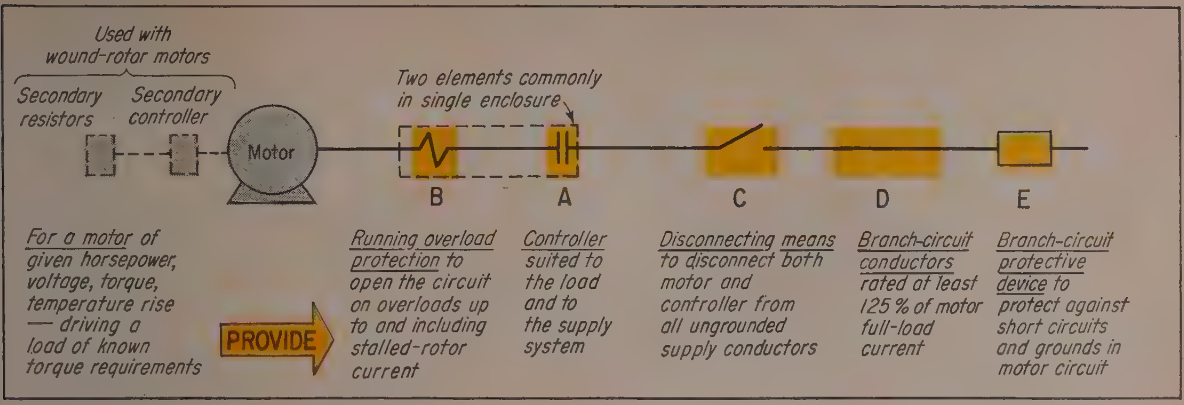
As used in the code, the term "controller" includes any switch or device normally used to start and stop a motor, in addition to motor controllers as such. The basic requirements for sizes and types of motor controllers are as follows (refer to Fig. 2):

1. A controller must be capable of starting and stopping the motor which it controls, and for an ac motor must be able to interrupt the stalled-rotor current of the motor.

2. A controller must have horsepower rating not lower than the rating of the motor, except—

3. The branch circuit protective device may serve as the controller for motors under ⅛ hp which are normally left running and are not

FIG. 1—Basic Elements of Motor Circuit


Used with wound-rotor motors
Secondary resistors
Secondary controller
Motor
Two elements commonly in single enclosure
B
A
C
D
E
For a motor of given horsepower, voltage, torque, temperature rise — driving a load of known torque requirements
PROVIDE
Running overload protection to open the circuit on overloads up to and including stalled-rotor current
Controller suited to the load and to the supply system
Disconnecting means to disconnect both motor and controller from all ungrounded supply conductors
Branch-circuit conductors rated at least 125% of motor full-load current
Branch-circuit protective device to protect against short circuits and grounds in motor circuit

subject to damage from overload or failure to start. Clock motors are typical of this application.

4. A plug and receptacle connection may serve as the controller for portable motors up to ⅓ hp.

5. A general-use switch rated at not less than twice the full-load motor current may be used as the controller for stationary motors up to 2 hp, rated for operation at 300 volts or less.

On ac circuits, general-use snap switches suitable only for use on ac may be used to control a motor having a full-load current rating not over 80% of the ampere rating of the switch.

6. A branch-circuit circuit breaker, rated in amperes only, may be used as a controller. If the same circuit breaker is used to provide overcurrent protection for the motor circuit, it must be rated accordingly.

For sealed (hermetic-type) refrigeration compressor motors, selection of the size of controller is slightly more involved than it is for standard applications. Because of their low-temperature operating conditions, hermetic motors can handle heavier loads than general purpose motors of equivalent size and rotor-stator construction. And because the capabilities of such motors cannot be accurately defined in terms of horsepower, they are rated in terms of full-load current and locked-rotor current for polyphase motors and larger single-phase motors. Selection of controller size is accordingly different than in the case of a general-purpose motor where horsepower ratings must be matched.

For controllers rated in horsepower, selection of the size required for a particular hermetic motor can be made after the full-load and locked-rotor currents of the motor have been converted to an equivalent horsepower rating. To get this equivalent horsepower rating, which is the required size of controller, the tables in Article 430 of the NEC must be used. First, the nameplate full-load current of the motor is found in Table 430-148, 430-149 or 430-150 and the horsepower rating which corresponds to it is noted. Then the nameplate locked-rotor current of the motor is found in Table 430-151 and again the corresponding horsepower is noted. In both tables, if

FIG. 2—Code Rules on Motor Controllers

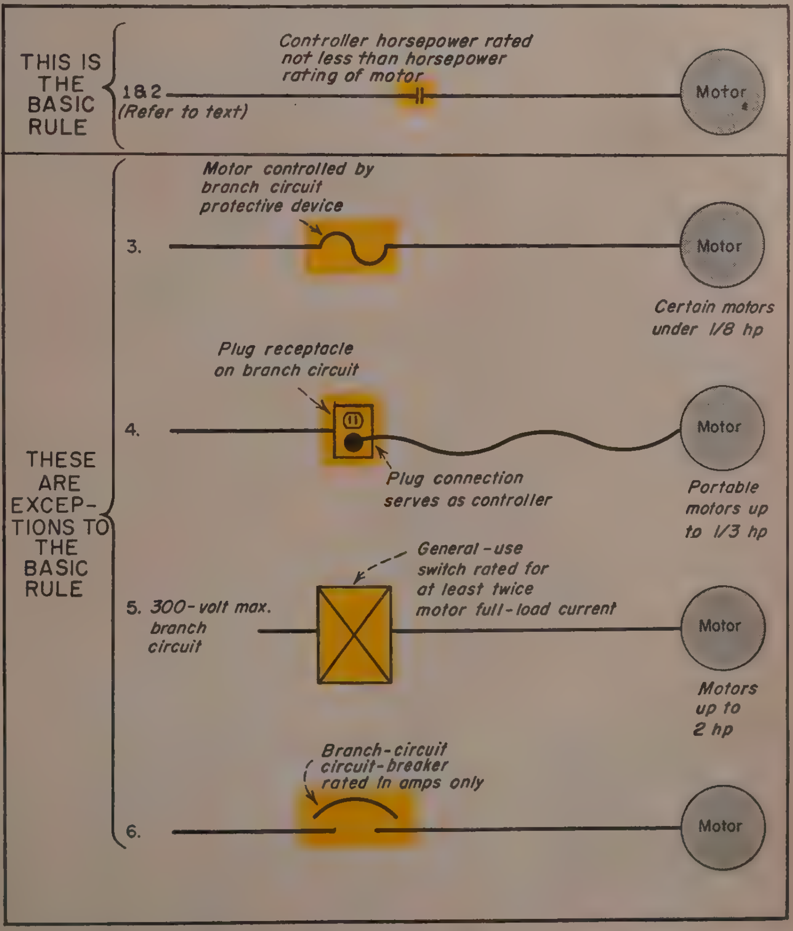

THIS IS THE BASIC RULE
1&2
(Refer to text)
Controller horsepower rated not less than horsepower rating of motor
Motor
THESE ARE EXCEPTIONS TO THE BASIC RULE
3.
Motor controlled by branch circuit protective device
Motor
Certain motors under 1/8 hp
4.
Plug receptacle on branch circuit
Plug connection serves as controller
Motor
Portable motors up to 1/3 hp
5. 300-volt max. branch circuit
General-use switch rated for at least twice motor full-load current
Motor
Motors up to 2 hp
6.
Branch-circuit circuit-breaker rated in amps only
Motor

FIG. 3—Selecting Controller for Hermetic Motor

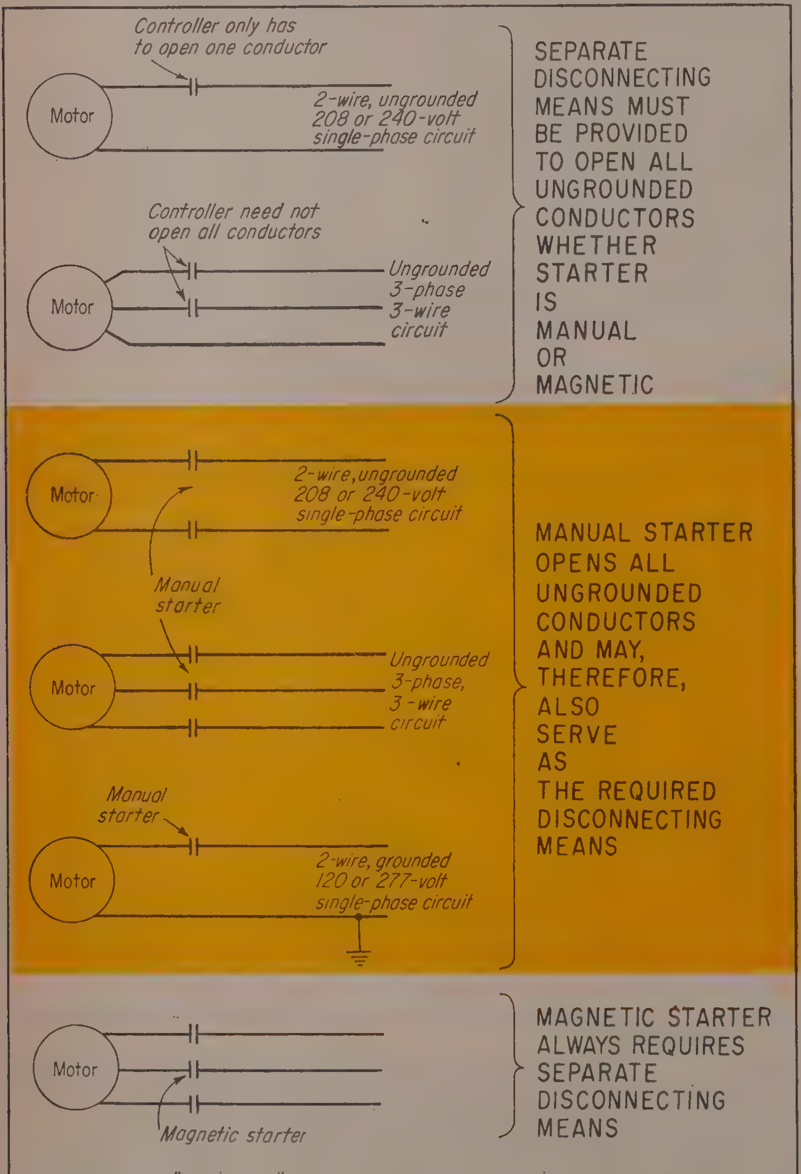
The nameplate full-load current and the nameplate locked-rotor current of a sealed (hermetic-type) refrigeration compressor motor are used to select the proper size of motor controller to use.

Given: a 220-volt, 3-phase, squirrel-cage induction motor in a compressor.
Nameplate full-load current..............25.8 amps
Nameplate locked-rotor current............90 amps

From Table 430-150, Article 430, NEC, 27 amps is the next higher current to the nameplate current of 25.8, and the corresponding horsepower rating for a 220-volt, 3-phase motor is 10 hp.

From Table 430-151, Article 430, NEC, a locked-rotor current rating of 90 amps for a 220-volt, 3-phase motor requires a controller rated at 5 hp. The two values of horsepower obtained are not the same, so the higher rating is selected as the acceptable unit for the conditions. Although it requires a 10-hp controller, the motor has a rating of only 5 hp.

FIG. 4—Controller Need Not Open All Conductors to Motor


Controller only has to open one conductor
Motor
2-wire, ungrounded 208 or 240-volt single-phase circuit
Controller need not open all conductors
Motor
Ungrounded 3-phase 3-wire circuit
SEPARATE DISCONNECTING MEANS MUST BE PROVIDED TO OPEN ALL UNGROUNDED CONDUCTORS WHETHER STARTER IS MANUAL OR MAGNETIC
Motor
2-wire, ungrounded 208 or 240-volt single-phase circuit
Manual starter
Motor
Ungrounded 3-phase, 3-wire circuit
Manual starter
Motor
2-wire, grounded 120 or 277-volt single-phase circuit
MANUAL STARTER OPENS ALL UNGROUNDED CONDUCTORS AND MAY, THEREFORE, ALSO SERVE AS THE REQUIRED DISCONNECTING MEANS
Motor
Magnetic starter
MAGNETIC STARTER ALWAYS REQUIRES SEPARATE DISCONNECTING MEANS

Note: The word "ungrounded" above refers to the condition that none of the circuit conductors is grounded. These may be the ungrounded conductors of grounded systems.

the exact value of current is not listed, the next higher value should be used. If the two horsepower ratings obtained in this way are not the same, the larger value is taken as the required size of controller. A typical example is shown in Fig. 3.

Some controllers may be rated not in horsepower but in full-load current and locked-rotor current. For use with a hermetic motor, such a controller must have current ratings equal to or greater than the nameplate full-load current and locked-rotor current of the motor.

It is interesting to note that the NEC says that a controller need not open all conductors to a motor, except when the one device used for the controller also serves as the disconnect means, in which case all ungrounded conductors to the motor must be opened. The controller must only interrupt enough conductors to be able to start and stop the motor. Fig. 4 illustrates this point. However, when a manual starting switch is used with a motor supplied from a 2-wire (both ungrounded), 240-volt or 208-volt single-phase circuit or from a 3-phase, 3-wire (all three ungrounded) circuit, all ungrounded conductors to the motor must be opened by the switch if it is to serve the dual function of disconnect and controller. And it should be noted here that only a manually operated switch or circuit breaker may serve such a dual function. A magnetic starter cannot also serve as the disconnecting means.

Still another code requirement on motor controllers concerns the installed location. Basically, the code requires that the motor and its driven machinery be within sight from the controller for the motor. When the controller is not so located (and the code considers a distance of 50 ft to be equivalent to "out of sight," even though the motor and its load might actually be visible from the controller location), the controller must comply with one of the following conditions:

a. The controller or its disconnecting means is capable of being locked in the open position, unless special permission is granted by the authority enforcing the code.

b. A manually operable switch, which will prevent the starting of the motor, is placed within sight from the motor location. And this switch may be placed in the control circuit of a magnetic starter. These requirements are shown in Fig. 5.

Generally, an individual motor controller is required for each motor. However, for motors rated not over 600 volts, a single controller may be used with a group of motors in any one of the following cases:

1—If a number of motors drive several parts of a single machine or piece of apparatus—metal and wood-working machines, cranes, hoists, etc.

2—If two or more motors are under protection of one overcurrent device as in the case of small motors supplied from a single branch circuit. A single branch circuit may be used to supply two or more motors when each of the motors is rated not more than 1 hp and draws not more than 6 amps full-load current. Such a circuit must be protected at not more than 20 amps at 125 volts or less, or not more than 15 amps at 600 volts or less. An individual running overcurrent protective device must be provided for each of the motors, unless: a motor is portable, manually started and within sight from the controller location; a motor has sufficient winding impedance to prevent overheating due to stalled rotor current; or a motor is part of an approved assembly which does not subject the motor to overloads and which incorporates protection for the motor against stalled rotor.

3—If a group of motors is located in one room and all are within sight from the controller location.

On the subject of motor controllers, the code further requires that speed-limiting devices be used with separately-excited dc motors, with series motors and with motor-generators and converters which can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load. Exceptions to this general requirement are allowed in cases where the machine, the system or the connection to the load and the load itself safely limits the speed or where an operator has constant manual control of the machine.

B—OVERLOAD PROTECTION

The code makes specific requirements on motor running overcurrent (overload) protection, intended to protect the elements of the branch circuit—the motor itself, the motor control apparatus and the branch circuit conductors—against excessive heating due to motor overloads. Such overload is considered to be operating overcurrent which, when it persists for sufficient length of time, would cause damage or dangerous overheating of the apparatus. It does not include fault currents due to short circuits or grounds.

Basic code requirements are concerned with the rating or setting of the devices and are illustrated in Fig. 6. However, the code permits the use of thermal protectors integral with motors, provided such devices are approved for their particular applications and that they do prevent dangerous overheating of the motors.

Under certain conditions, no specific running overload protection need be used. The motor is considered to be properly protected if it is part of an approved assembly which does not normally subject the motor to overloads and which has controls to protect against stalled rotor. Or if the impedance of the motor windings is sufficient to prevent overheating due to failure to start, the branch-circuit protection is considered adequate.

FIG. 5—Required Location of Controller

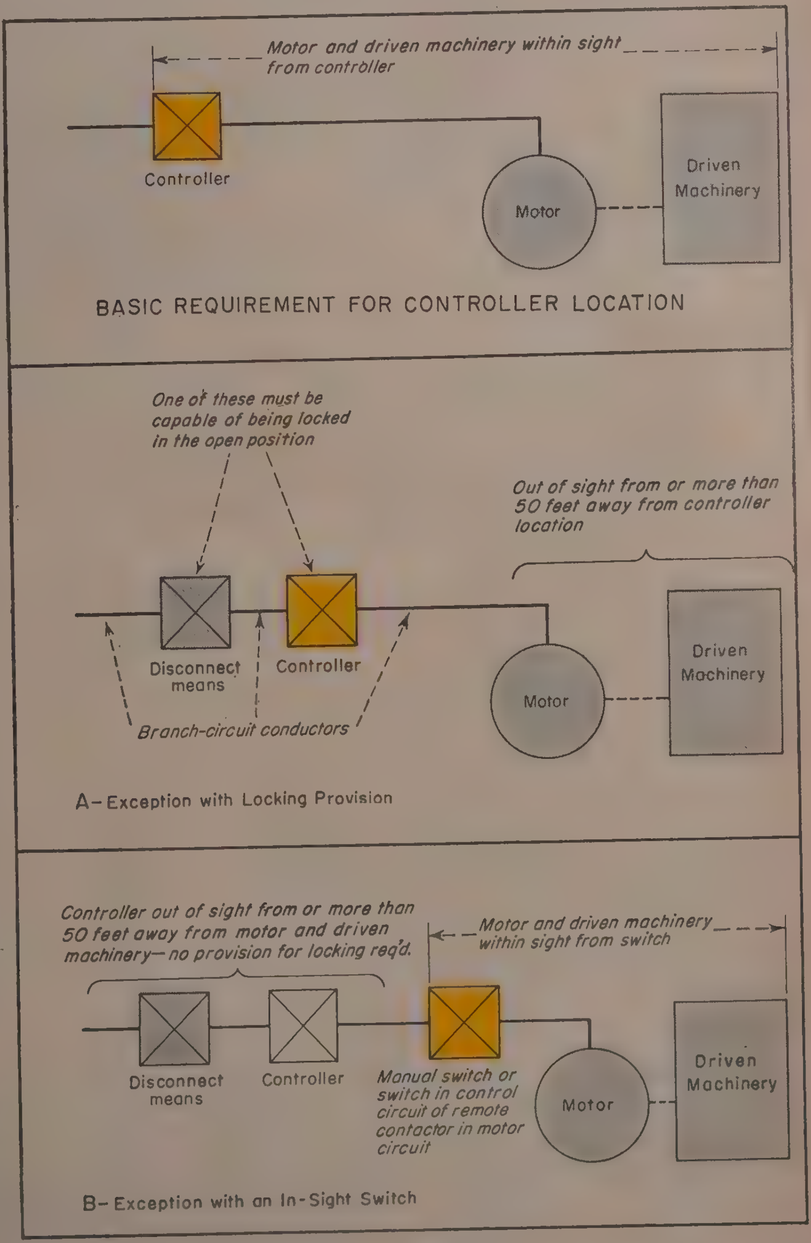

Motor and driven machinery within sight from controller
Controller
Motor
Driven Machinery
BASIC REQUIREMENT FOR CONTROLLER LOCATION
One of these must be capable of being locked in the open position
Out of sight from or more than 50 feet away from controller location
Disconnect means
Controller
Motor
Driven Machinery
Branch-circuit conductors
A- Exception with Locking Provision
Controller out of sight from or more than 50 feet away from motor and driven machinery—no provision for locking req'd.
Motor and driven machinery within sight from switch
Disconnect means
Controller
Manual switch or switch in control circuit of remote contactor in motor circuit
Motor
Driven Machinery
B- Exception with an In-Sight Switch

FIG. 6—Basic Requirements on Running Overload Protection

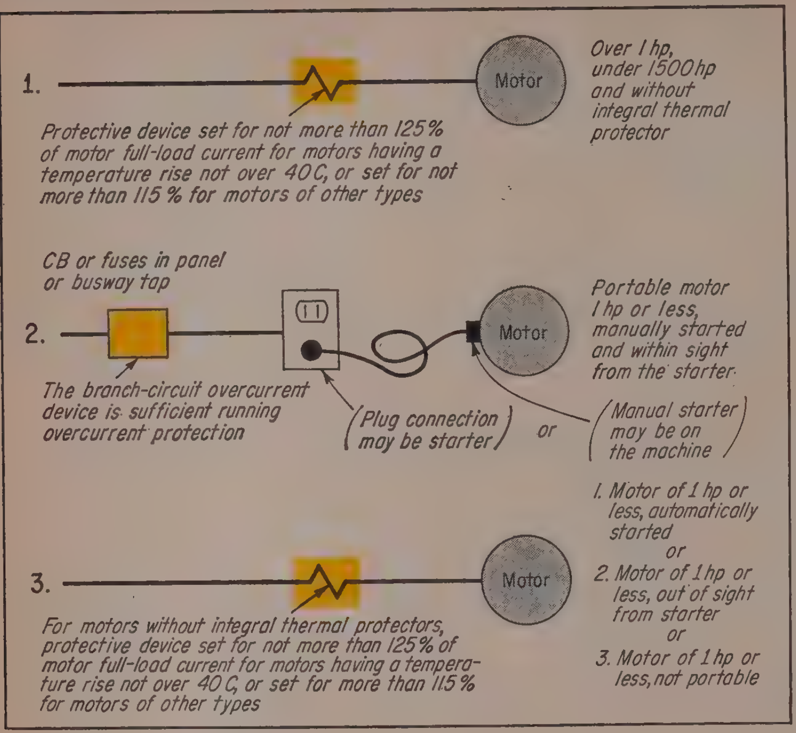
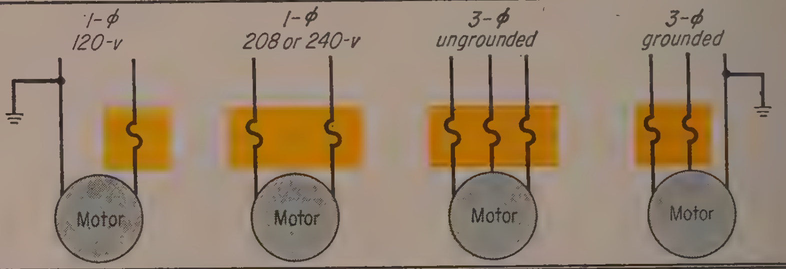

1.
Motor
Over 1 hp, under 1500 hp and without integral thermal protector
Protective device set for not more than 125% of motor full-load current for motors having a temperature rise not over 40C, or set for not more than 115% for motors of other types
CB or fuses in panel or busway tap
2.
Motor
Portable motor 1 hp or less, manually started and within sight from the starter
The branch-circuit overcurrent device is sufficient running overcurrent protection
Plug connection may be starter
or
Manual starter may be on the machine
1. Motor of 1 hp or less, automatically started
or
2. Motor of 1 hp or less, out of sight from starter
or
3. Motor of 1 hp or less, not portable
3.
Motor
For motors without integral thermal protectors, protective device set for not more than 125% of motor full-load current for motors having a temperature rise not over 40 C, or set for more than 115% for motors of other types

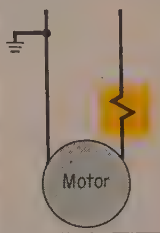
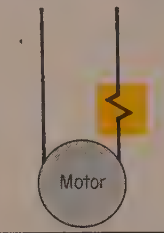
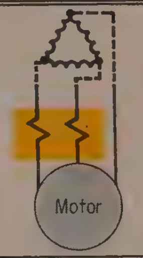
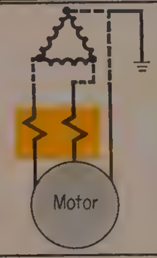
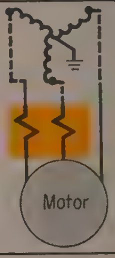
Fig. 7 shows the number of protective devices to be used with various circuits and the locations of the devices. Complete data on the number and location of overcurrent devices is given in Table 430-37 of the code.

Consistent with the engineering basis for code requirements, motor starters are generally provided with one overload relay in 2-pole starters and with two relays in 3- and 4-pole starters. However, in recent years, increasing experience with motors on large, high-capacity electrical systems has clearly indicated the need, under certain conditions, for an overload protective device in each hot leg of a 3-phase motor circuit. It has been found that primary single-phasing can cause burnouts of motors connected to secondary distribution systems supplied from wye-delta or delta-wye transformers (with the wye neutral point in the primary ungrounded or not connected to the circuit). Fig. 8 illustrates the problem. For this reason, electrical inspectors are empowered to require

FIG. 7—Number and Location of Running Overcurrent Devices

WHEN FUSES ARE USED FOR RUNNING PROTECTION ONE MUST BE PLACED IN EACH UNGROUNDED CONDUCTOR



TRIP-COILS, RELAYS OR THERMAL CUTOUTS USED FOR RUNNING PROTECTION					
TYPE OF CIRCUIT SUPPLYING MOTOR	2-wire, 1-φ, Grounded	2-wire, 1-φ, Ungrounded	3-wire, 3-φ, Ungrounded from delta	3-wire, 3-φ, From grounded delta	3-wire, 3-φ, Ungrounded wires from grounded neutral wye
MIN. NUMBER & LOCATION OF OVERCURRENT UNITS	One— in ungrounded conductor	One— in either ungrounded conductor	Two— in any two conductors	Two— in ungrounded conductors	Two— in any two conductors

the use of three relays on a 3-phase starter where need is indicated. And this is frequently made a specification requirement by engineers. Such additional protection can usually be added to starters and some starters are made with three overload relays as standard.

Fig. 9 points up an important detail of overload protection.

C—DISCONNECTING MEANS

The code specifically requires that a disconnecting means be provided in each motor circuit to disconnect both the motor and its controller from all ungrounded supply conductors.

Fig. 10 covers installation details on disconnecting means, and Fig. 11 sets forth basic code requirements on types of disconnect.

Again, as mentioned under "Controller," a manual switch may serve the functions of controller and disconnecting means in a motor circuit if the switch opens all ungrounded conductors to the motor. And circuit breakers may also be used as dual function devices. However, it is important to note that an autotransformer type controller always requires a separate disconnecting means.

The above-mentioned acceptability of a single switch for both the controller and disconnecting is based on the single switch satisfying the code requirements for a controller and for a disconnect. It finds application where general-use switches or horsepower-rated switches are used, as permitted by the code, in conjunction with time-delay fuses which are rated low enough to provide both running overload protection and branch-circuit (short-circuit) protection. In such cases, a single fused switch may serve a total of four functions. And it is possible for a single circuit breaker to also serve four functions. Such application, however, requires extreme care in matching the time-current heating curve of the motor and the starting characteristics of the motor and its load to the operating curve of the protective device.

D—BRANCH-CIRCUIT CONDUCTORS

The basic code rule says that the conductors supplying a single motor must have a current-carrying capacity of not less than 125% of the motor full-load current rating. Conductors supplying two or more motors must have a current rating not less than 125% of the full-load current rating of the largest motor supplied plus the sum of the full-load current ratings of the remainder of the motors supplied. Of course, these are minimum conductor ratings based on temperature rise only and do not take into account voltage drop or power loss in the conductors. Such considerations usually require increasing the size of branch-circuit conductors.

FIG. 8—Dangerous Operating Condition With Only Two Overload Relays

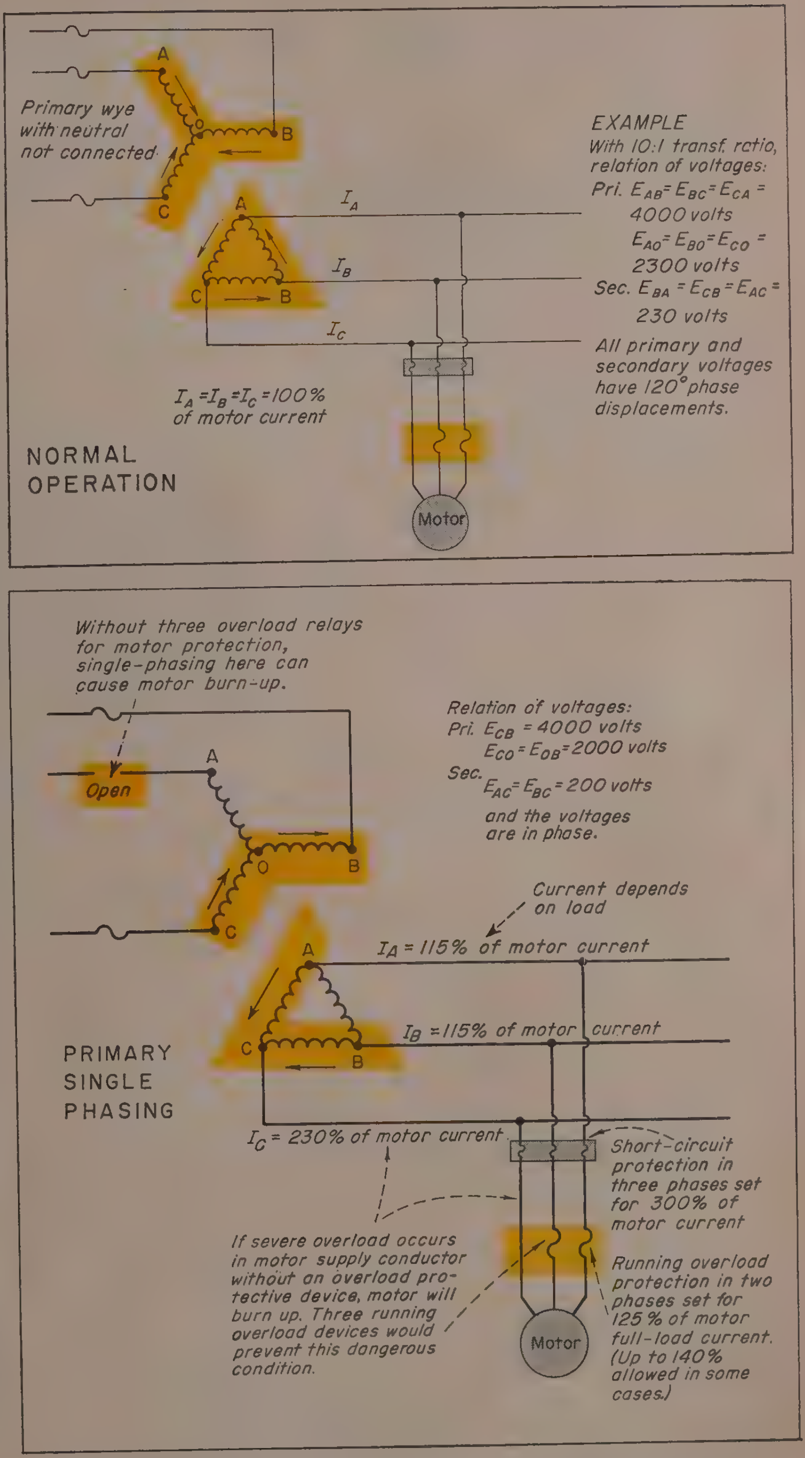
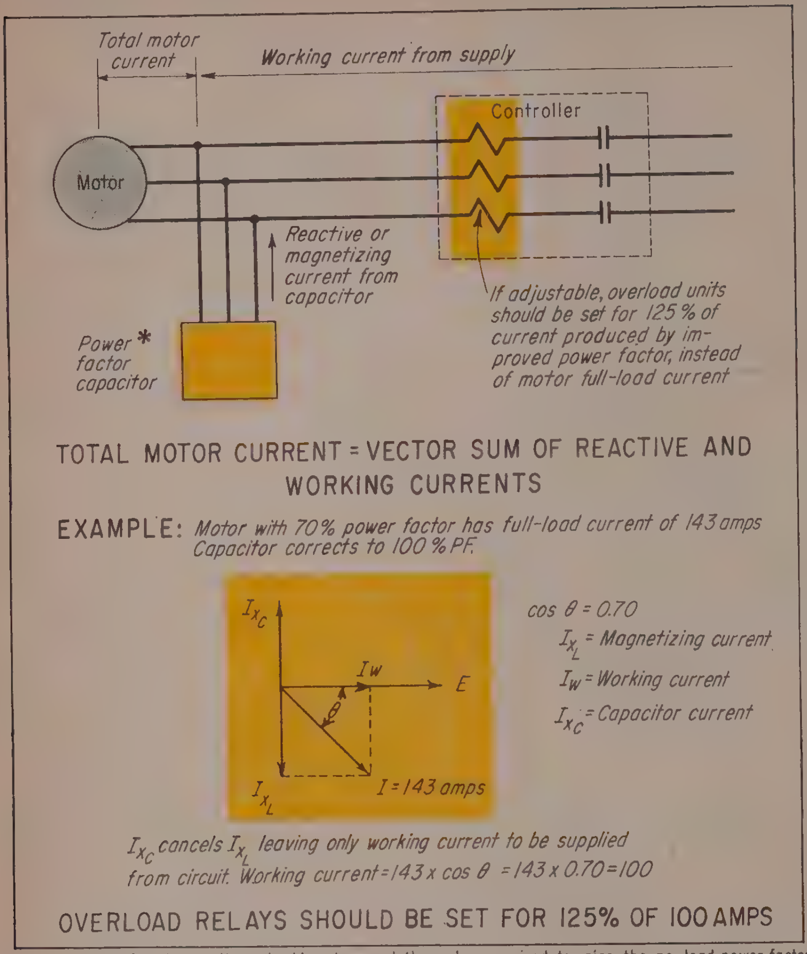


FIG. 9—Correcting Overload Protection for Load-Side Capacitors



If adjustable, overload units should be set for 125% of current produced by improved power factor, instead of motor full-load current

TOTAL MOTOR CURRENT = VECTOR SUM OF REACTIVE AND WORKING CURRENTS

EXAMPLE: Motor with 70% power factor has full-load current of 143 amps Capacitor corrects to 100% PF.

$\cos\theta = 0.70$

I_{X_L} = Magnetizing current

I_W = Working current

I_{X_C} = Capacitor current

I_{X_C} cancels I_{X_L} leaving only working current to be supplied from circuit. Working current $= 143 \times \cos\theta = 143 \times 0.70 = 100$

OVERLOAD RELAYS SHOULD BE SET FOR 125% OF 100 AMPS

* The rating of such capacitors should not exceed the value required to raise the no-load power factor of the motor to unity. Capacitors of these maximum ratings usually result in a full-load power factor of 95 to 98 percent.

It should be noted that the code makes certain provisions for determining current-carrying capacities:

For general motor applications (excluding applications of sealed hermetic-type refrigeration compressor motors), whenever the current rating of a motor is used to determine the current-carrying capacity of conductors, switches, branch-circuit overcurrent devices or circuit breakers, the values given in code Tables 430-147, 430-148, 430-149 and 430-150 shall be used instead of the actual current rating marked on the motor nameplate. However, selection of motor running overcurrent protection MUST be based on the actual motor nameplate current rating.

For sealed (hermetic-type) refrigeration compressor motors, the actual nameplate full-load running current of the motor must be used in determining the current rating of branch-circuit conductors, short-circuit protection and running overload protection.

E—SHORT-CIRCUIT PROTECTION

The code requires that branch-circuit protection for motor circuits must protect the circuit conductors, the control apparatus and the motor itself against overcurrent due to short circuits or grounds.

The first, and obviously necessary, rule is that the branch-circuit protective device must be capable of carrying the starting current of the motor without opening the circuit. Then the code proceeds to place maximum values on the ratings or settings of such overcurrent devices. It says that such devices must not be rated in excess of the values given in Tables 430-152 or 430-153, except that, where absolutely necessary for motor starting, the device may be rated up to 400% of the motor full load running current. Table 430-146 presents a wide range of data on the makeup of motor branch circuits and should be thoroughly familiar to circuit designers.

It should be noted that the code establishes maximum values for branch-circuit protection, setting the limit of safe application. However, use of smaller sizes of branch-circuit protective devices is obviously permitted by the code and does offer opportunities for substantial economies in selection of circuit breakers, fuses and the switches used with them, panelboards, etc. In any application, it is only necessary that the branch-circuit device which is smaller than the usual 300% of motor current must have sufficient time delay in its operation to permit the motor starting current to flow without opening the circuit.

A circuit breaker for branch-circuit protection must have a continuous current rating of not less than 115% of the motor full load current.

FIG. 10—Installation of Disconnect

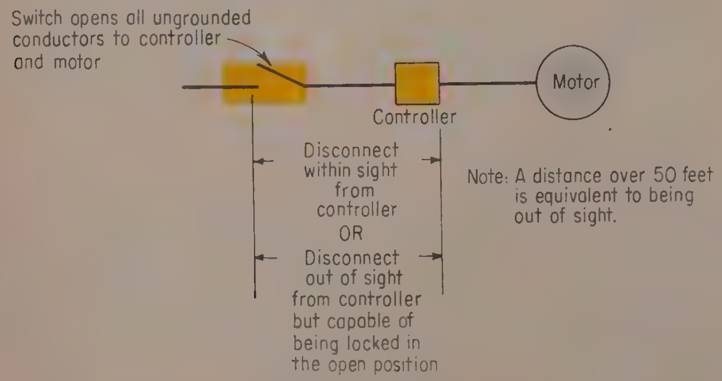
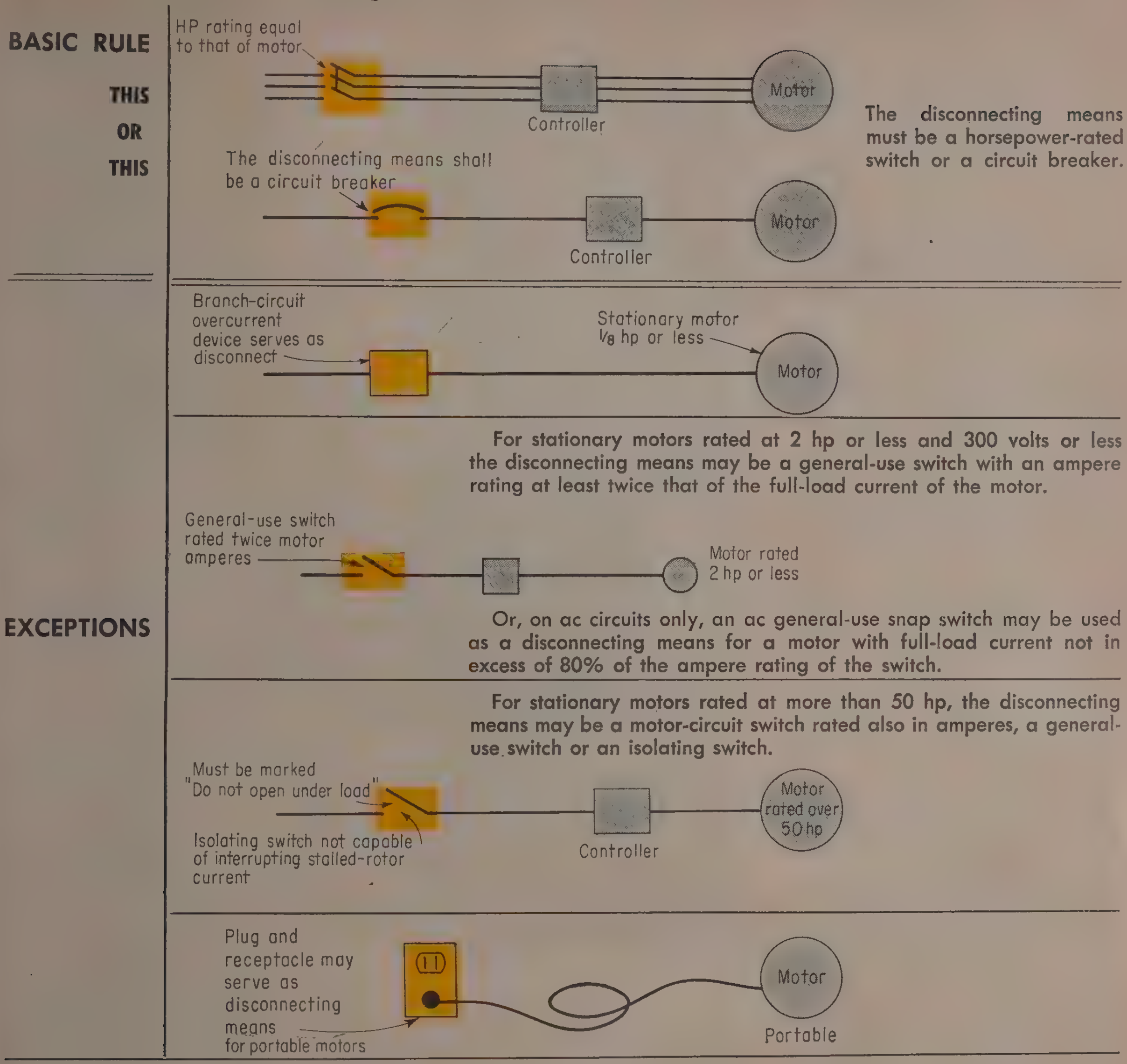

Switch opens all ungrounded conductors to controller and motor
Controller
Motor
Disconnect within sight from controller
OR
Disconnect out of sight from controller but capable of being locked in the open position
Note: A distance over 50 feet is equivalent to being out of sight.

FIG. 11—Required Disconnecting Means


BASIC RULE
THIS
OR
THIS
HP rating equal to that of motor
Controller
Motor
The disconnecting means shall be a circuit breaker
Controller
Motor
EXCEPTIONS
Branch-circuit overcurrent device serves as disconnect
Stationary motor 1/8 hp or less
Motor
General-use switch rated twice motor amperes
Motor rated 2 hp or less
Must be marked "Do not open under load"
Isolating switch not capable of interrupting stalled-rotor current
Controller
Motor rated over 50 hp
Plug and receptacle may serve as disconnecting means for portable motors
Motor
Portable

The disconnecting means must be a horsepower-rated switch or a circuit breaker.

For stationary motors rated at 2 hp or less and 300 volts or less the disconnecting means may be a general-use switch with an ampere rating at least twice that of the full-load current of the motor.

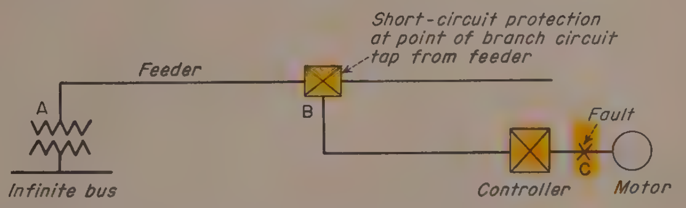
Or, on ac circuits only, an ac general-use snap switch may be used as a disconnecting means for a motor with full-load current not in excess of 80% of the ampere rating of the switch.

For stationary motors rated at more than 50 hp, the disconnecting means may be a motor-circuit switch rated also in amperes, a general-use switch or an isolating switch.

Fig. 12 calls attention to the fact that branch-circuit protection must always be capable of interrupting the amount of short-circuit current which might flow through it. And the speed of clearing the circuit must be compared to the abilities of the various circuit elements to withstand the damaging effects of short-circuit current flow during the time it does take the protective device to operate. Short-circuit protection must be coordinated with the controller and other apparatus.

Within the framework of the above requirements, design of motor control circuits requires a clear and organized understanding of the operating principles of all types of motor controllers.

FIG. 12—Effective Short-Circuit Protection


Short-circuit protection at point of branch circuit tap from feeder
Feeder
A
B
Infinite bus
Fault
C
Controller
Motor

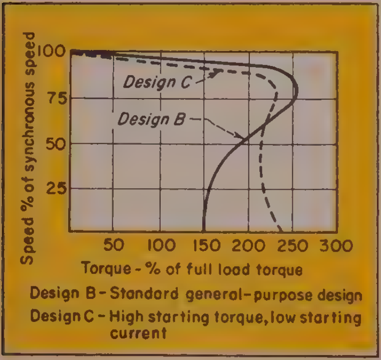
A short-circuit fault at C will draw current until the circuit is opened by the protection at B. The value of the short-circuit current available at C depends upon the kva rating of the supply transformer, the percent reactance of the transformer, the secondary voltage and the effective impedance of the current path from the transformer to the point of fault. Application of motor controllers must, therefore, be coordinated with branch-circuit overcurrent protection which must be able to safely interrupt the short-circuit current. And not only must the device be rated to interrupt the fault current, it must act quickly enough to open the circuit before let-through current can damage the controller.

Alternating-Current Controls

Controllers for ac motors can readily be divided into two types according to the condition of starting voltage: full-voltage controllers and reduced-voltage controllers. A full-voltage or across-the-line controller is one which connects its controlled motor directly to full value of the motor circuit voltage. A reduced-voltage controller, as the name implies, initially connects the motor to a value of voltage less than that of the supply circuit and then increases the voltage gradually until full circuit voltage is impressed across the motor terminals.

Any polyphase induction motor can be started safely using a full-voltage controller, without doing damage to the motor. Under proper conditions, any size of motor on any voltage can be started at full-voltage. However, when the full voltage is impressed, the initial or starting current surge drawn from the line might be as much as eight times the normal running current of the motor. The motor itself can handle the current and will start developing rotation; but the driven load may be damaged by the shock of starting torque of the motor, and severe voltage disturbances may be set up in the distribution system supplying the motor. In such cases, it might be better or it might be necessary to start the motor on reduced voltage to minimize objectionable characteristics. A number of factors are involved in the problem: the nature of the driven load, the characteristics of the motor, required characteristics of acceleration, the duty cycle of the motor and the characteristics of the supply system. Fig. 13 presents basic data on the characteristics of squirrel-cage motors. Generally, manufacturer's recommendations and some basic calculations can be combined with load characteristics to determine the best starting method.

FIG. 13—Typical Data on Speed, Torque and Currents in Squirrel-Cage Motors



Design A motors have locked-rotor current exceeding Design B motors, same locked-rotor torque, and higher break-down torque.

Design B motors are the standard, forming basis for comparative performance of other types. Torque, starting current and slip characteristics make them suitable for most applications. Efficiency is relatively high—even under fractional loads. Power factor is good at full load, but drops quite rapidly with decrease in load. Efficiency and power factor decrease as number of poles increase.

Design C motors have higher locked-rotor torque but lower break-down torque than Design B motors; locked-rotor current and slip are same for two designs. Design C is for applications requiring high initial torque to start, such as vibrating screens, conveyors and compressors without unloading devices. In addition to lower break-down torque, Design C motors sacrifice efficiency and power to some extent.

Design D motors have high torque and high slip. They are generally used on applications involving high inertia and frequent load changes, such as flywheel-equipped punch presses.

High slip enables motor to pick up load when excess energy stored in flywheel has been released during working stroke of cycle. High torque enables motor to repeatedly accelerate load to full speed, without overheating, to restore energy to flywheel.

ACROSS-THE-LINE STARTING

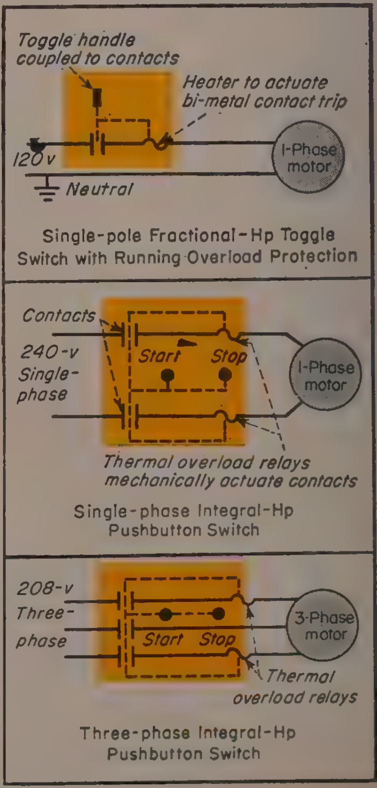
In small and moderate size motor applications, the torque, speed and power requirements of the driven load generally permit full-voltage starting without objectionable results. Under such conditions, an across-the-line starter may be used.

Across-the-line or full-voltage motor controllers can be divided into two categories according to the manner in which the contacts in the starter are closed or opened. In the MANUAL starter, the contacts are operated by a mechanical linkage from the toggle handle or pushbuttons provided with the unit. In the MAGNETIC starter, the contacts are operated by the force of an electromagnetic coil which is controlled by switching the energy to the coil. A wide variety of types and sizes of starters are made in both of these categories.

MANUAL STARTERS

The simplest type of manual starting switch is the 1- or 2-pole fractional-horsepower toggle switch used for infrequent starting and stopping of single-phase motors, up to a maximum of 1 hp at 120 or 240 volts. This switch consists of a basic snap-action mechanism which connects the motor to the line in the "ON" position and disconnects it in the "OFF" position. To provide running overload protection,

FIG. 14—Manual Starting



Single-pole Fractional-Hp Toggle Switch with Running Overload Protection

Single-phase Integral-Hp Pushbutton Switch

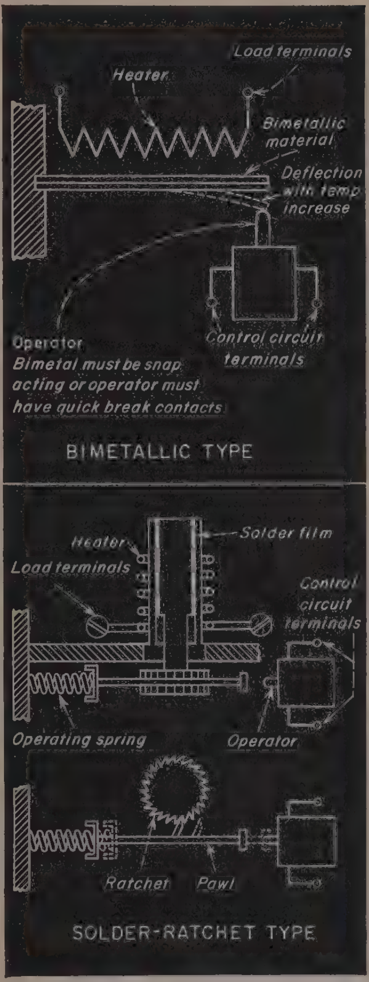
Three-phase Integral-Hp Pushbutton Switch the small assembly will also probably contain a thermal device to open the circuit on overload, as shown in Fig. 14.

A number of types of overload devices are used for fractional-hp switches. One type of overload device operates on the soldered-ratchet principle—(1) a small cylinder contains an alloy that will melt when an overload occurs and persists, (2) a small shaft to which a ratchet wheel is attached is imbedded in the metal, (3) when the contact mechanism is moved to the "ON" position, a spring element engages the ratchet wheel, (4) if an overload occurs, the heat of the excessive current passing through a heater coil in series with the line melts the alloy, and the ratchet wheel relieves the pressure holding the contacts closed, (5) the circuit opens. To restart the motor after the overload has been removed, it is necessary to permit the alloy to reharden before closing the switch. Another type of thermal overload device uses a heater coil to melt a solder film when overload current flows, tripping a mechanism and opening the main contacts of the switch. Still another type of device consists of a resistance-wire heater coil connected in the circuit conductors to the motor. When the current drawn by the motor exceeds the safe value and persists in excess, the heat produced warps a bi-metallic strip which opens the contacts. Fig. 15 shows two types of overload relays, as they would be connected to open the operating coil of a magnetic starter. In a manual starter, the contacts would control the load to the motor.

Construction of the contact mechanism and its coupling to the thermal overload device is such that the switch cannot be held closed against a sustained motor overload. Depending upon the exact nature of the overload device, the switch is reset for use after an overload by cooling and return of the handle to the "OFF" position. Of course, the calibration of overload devices is made to prevent tripping on harmless transient overloads, such as starting current surge.

Fractional-hp starting switches are available in many variations and combinations. Basic 1- or 2-pole switches are made with toggle type handles, with key-operated mechanism and with lever type handles to which linkage can be attached. Units of one or two switches are made with pilot lights as part of the assembly, and units are available with a selector switch to permit inclusion of the starter in an automatic control circuit, with a position for manual operation. Fractional-hp switches are available in open type construction for use in standard switchboxes with flush plates and in general purpose, dust-tight, water-tight and explosion-proof enclosures.

FIG. 15—Two Types of Thermal Overload Relays


Load terminals
Heater
Bimetallic material
Deflection with temp increase
Operator
Control circuit terminals
Bimetal must be snap acting or operator must have quick break contacts
BIMETALLIC TYPE
Solder film
Heater
Load terminals
Control circuit terminals
Operating spring
Operator
Ratchet
Pawl
SOLDER-RATCHET TYPE

Common applications for fractional-hp manual motor starters include:

Unit heaters
Fans
Pumps
Small machine tools
Small presses

Manual starting switches for use with single-phase and polyphase integral-hp motors are across-the-line starters containing electrical contact assemblies which are opened and closed by mechanical action, Fig. 14. The manual operation may be effected either by pushbuttons or by a toggle handle, mechanically coupled to the contact assembly and protruding through the starter enclosure. Starters of this type may be used on motor circuits rated up to 600 volts ac, for single-phase motors rated up to 5 hp, and for polyphase motors rated up to 7½ hp. Running overload protection is provided by thermal relay assemblies similar to those used in fractional-hp starters. The protective device responds to overload current by opening the circuit to the motor, and the operating handle cannot be used to hold the circuit closed against overload conditions. Provision is made in the starter to permit resetting of the overload device; but until the overload has been removed from the motor, the device will continue to trip the circuit when the starter is closed to the "ON" position.

Although manual starters are equipped with running overload protection, they do not have low voltage or undervoltage protection. As a result, a power failure will stop the controlled motor but will not disconnect it from the supply line. The starter contacts will remain closed and the motor will start immediately upon return of power. This can be hazardous. To avoid such action, manual starters must be opened on power failure.

Integral-hp manual starters are made in open form and for use in general-purpose, dust- and water-tight and explosion-proof enclosures, with guards alongside toggle handles and around pushbuttons to prevent accidental tripping of the starter mechanism.

General applications of integral-hp manual starters include ac and dc motor control where remote pushbutton control is not required, where the operator is in attendance at the driven load and needs control there, and where conditions eliminate any hazard due to sudden restarting of motors upon return of power after a failure. Common uses of these starters include the following:

Fans and blowers
Grinders
Punch presses
Buffers
Planers
Conveyors

In addition to the basic type of integral-hp manual starter, there are also some variations. The reversing manual starter is designed to manually reverse ac polyphase motors. The 2-speed manual starter is designed for operating 2-speed, separate-winding, star-connected motors. Both of these starter units consist of two standard integral-hp manual starters mounted on a common base plate and mechanically interlocked.

Another variation of the basic manual starter is the loom motor switch, designed especially for use on single or multiple shuttle textile looms. These switches have a toggle action suited to the special requirements of loom motor operations. The enclosure for the switch is lint-proof to protect completely against the entrance of lint. It also protects against the escape of sparks to reduce the fire hazards of weave rooms. These switches are made in the same general sizes as standard manual switches, with overload protection.

MAGNETIC ACROSS-THE-LINE STARTERS

A typical magnetic across-the-line starter is generally similar to the manual starter in the construction of the contact assembly; but instead of requiring mechanical, hand-applied force to open and close the contacts, the magnetic starter uses electromagnetic energy to actuate the contacts, Fig. 16. This starter connects the motor to its power supply conductors at full line voltage. And the unit is equipped with running overload protection and can provide protection against undervoltage. Magnetic across-the-line starters are made for single-phase and polyphase motors.

A typical magnetic across-the-line starter contains two sets of contacts—one set is stationary and the other is movable. The moving contacts are mounted to an armature or moving plunger of an electromagnet assembly. The stationary part of the magnet assembly consists of a coil in a fixed hollow case forming an electromagnetic structure of rectangular cross-section, in which the armature can move up and down. When current passes through the operating coil of such a starter, an electromagnetic field is set up, exerting a vertical force which pulls the armature toward it. When the armature makes its travel, it brings the moving contacts against the stationary contacts and closes the circuit to the motor. When current to the coil is interrupted, the electromagnetic field collapses, removing the force which holds the moving contacts against the stationary contacts. Without the vertical force, the weight of the armature and in some cases the action of springs separates the two sets of contacts.

The type of contactor operation described in the previous paragraph is called "solenoid" or "vertical lift" operation. Basically, this is the method of operation generally used in the smaller sizes of magnetic controllers, up to about 100 hp. And solenoid type starters are made in the larger sizes. However, there is another type of contactor operation also used in the larger sizes of starters, called "clapper" operation. In such a contactor, the magnet used is of a clapper type—the armature or moving part moves in a pivoted motion and "claps" into place against the electromagnet when the coil is energized. The magnet assembly is mounted alongside the contacts. The armature is connected to a rotating shaft on which the moving contacts are mounted, and movement of the armature pivots the moving contacts against the fixed contacts. Both solenoid and clapper type contactors are made with arc-quenching provisions.

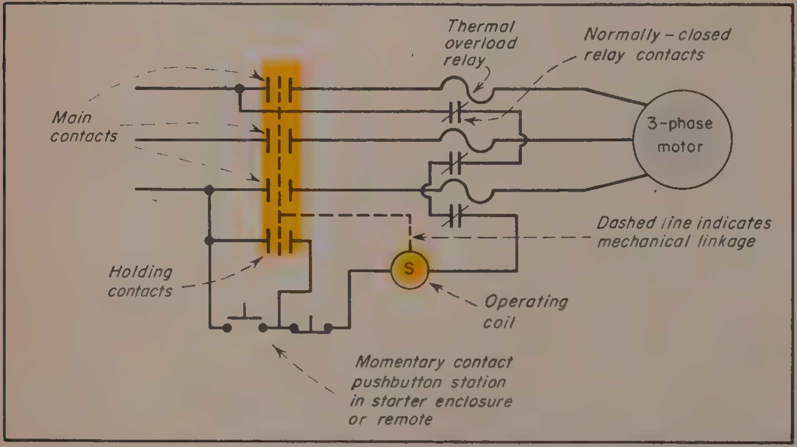
Operating Circuit

In the above descriptions of basic magnetic type starters, the holding coil is connected across two of the supply conductors on the line side of the starter contacts. The coil is a single-phase device in both single-phase and polyphase-starters. To control the current flow to the coil, thereby controlling movement of the contacts and starting and stopping of the controlled motor, some type of switching device must be connected in series with the coil. This switching device may be any one of a number of types of pilot actuators, depending upon the motor application and the control objectives. In its simplest form, the device may be a snap switch or a set of pushbuttons, mounted either in the starter enclosure itself or at a location away from the starter to provide remote control. Other switching devices which may be used to provide remote and automatic control of the starter include: float switches, pressure switches, limit switches, thermostats and control relays. With any of these devices, when the switching contacts close, the coil in the starter is energized. Opening the pilot contacts breaks the circuit to the coil, and the starter disconnects the motor from its supply. Connection of these devices to the starter is made with two wires.

Because of the ways in which a magnetic starter may be used, there are a number of common forms of operating construction—only an overload "RESET" button in the cover, a selector switch in the cover to provide manual operation, automatic operation or "OFF" position or a pushbutton station in the enclosure cover. The selector switch type of starter is advantageous where 2-wire pressure switch or thermostat control is used. Fig. 17 shows these three forms.

When the switch device which operates the holding coil of a

FIG. 16—Basic Magnetic Across-the-Line Starter with Three Overload Relays


Thermal overload relay
Normally – closed relay contacts
Main contacts
3-phase motor
Dashed line indicates mechanical linkage
S
Holding contacts
Operating coil
Momentary contact pushbutton station in starter enclosure or remote

starter is a momentary contact device, such as a momentary contact pushbutton, current flows through the coil only as long as the button contacts are closed. To provide maintained closure of the starter contacts even after the momentary contact is broken, a means must be provided for maintaining a closed circuit through the holding coil. This is commonly done by including in the starter a set of normally open holding contacts which are in parallel with the "START" button and are closed by the holding coil at the same time that the coil closes the main motor supply contacts. In such cases, the holding contacts are mechanically interlocked with the main contacts. In a typical pushbutton hookup, the "START" button is a normally-open momentary switch and the "STOP" button is a normally-closed switch. In the control circuit to the holding coil, both buttons are connected in series with each other and with the holding coil. When the "START" button is depressed, current flows through the holding coil, closing the starter and the holding contacts. When the "START" button is released, the holding contacts bridge the "START" button and maintain current flow through the holding coil. To stop the motor, the "STOP" button is depressed to break the series circuit to the holding coil. The main contacts then open. This type of control is called "3-wire" control because three wires must be connected between the pushbutton and the starter.

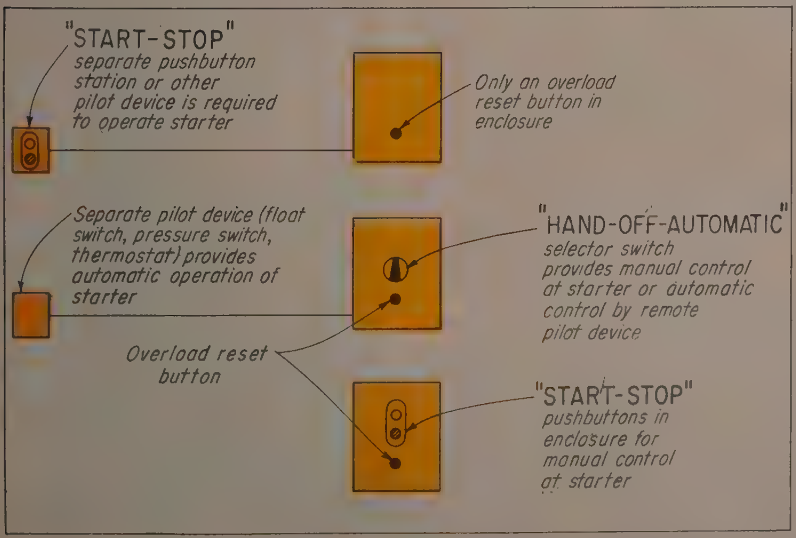
To afford ready adaptation of magnetic starters to a wide range of control applications, starters are available with electrical interlocks operating simultaneously with the main contacts. One set of normally-open control-circuit contacts, such as the holding contacts for momentary contact switching, is standard on magnetic starters. These contacts are used for 3-wire control circuits to the holding coil. Modern starters will generally accommodate a number of additional normally-open and/or normally-closed control circuit contacts.

Coil Voltage

In the starter hookups so far described, the operating coils are supplied at the voltage of a single phase of the power circuit to the motor. When control circuits are used with these starters, they must necessarily be of voltage rating corresponding to the rating of the holding coil. For the different voltages in which starters are available up to 600 volts, the coils have the same ratings. Pushbuttons and other pilot devices for use with such coils must also be of the same voltage rating. There are cases, however, when it is desirable to operate the coil of the starter at a voltage lower than that of the circuit to the motor. Such would be the case with high-voltage motor controllers or where low control voltage is desired for safety.

Motor controllers for magnetic across-the-line starting, rated up to 600 volts, are available with provision for control circuit operation from a low-potential separate source or from a control transformer. Typical equipment is supplied with a control transformer and fuse protection in its secondary.

FIG. 17—Three Forms of Enclosures for Non-Reversing Magnetic Starters


"START-STOP"
separate pushbutton station or other pilot device is required to operate starter
Only an overload reset button in enclosure
Separate pilot device (float switch, pressure switch, thermostat) provides automatic operation of starter
"HAND-OFF-AUTOMATIC"
selector switch provides manual control at starter or automatic control by remote pilot device
Overload reset button
"START-STOP"
pushbuttons in enclosure for manual control at starter

In the larger sizes of magnetic contactors, the use of ac magnets is generally unsatisfactory. Because such contactors are rated for heavy duty and carry heavy currents, their poles are large in size and contact pressure springs can be stiff. To use an ac magnet to operate the mechanism in such starters would require large mass and high inertia in the magnet, resulting in slow operating speed and excessive impact on closing. The shock of repeated closing of the contactor can easily "mushroom" a laminated magnet frame. To eliminate the difficulties inherent in ac magnet operation, solid dc magnets are used on large size contactors. Typical dc magnets are quieter than ac magnets and generally have longer mechanical life.

There are a number of ways in which direct-current operated contactors can be applied. When a source of dc energy is available in a plant, it can be used as is or modified depending upon its characteristics and the voltage and current requirements of dc coils which it is to supply. If no source of dc is available, one can be readily obtained by using any one of the many types of highly reliable static rectifier power supplies available and suitable for such use. However, the most reliable solution of the problem is the use of modern magnetic motor-control equipment which in the larger sizes incorporates an individual rectifier in each starter to supply the dc magnet, with a transformer and a relay to permit operation of the starter from an ac source. Such starters are made for the larger sizes of motors, 200 hp and up.

Overload Protective Devices

Motor running overload protection is a standard provision in magnetic across-the-line starters. Several different types of overload relays are used on the different types and sizes of controllers. Construction and operation of these devices is generally similar to the overload relays in the manual starters. However, instead of the thermal-type relays, magnetic starters in the larger sizes often use magnetic-type relay devices. In the various sizes of starters, typical overload devices include:

1. Heaters in series with line conductors acting upon thermal bi-metallic overload relays.

2. Overload devices using resistance or induction heaters and operating on the solder-ratchet principle.

Magnetic relays with adjustable instantaneous setting or adjustable time-delay setting are also used. Of course, the provisions for overload protection are integrated in the enclosure.

A magnetic-thermal overload device, for instance, operates on a basic transformer principle to develop heat to melt solder and trip relay contacts. In such a device, a fixed coil is used to induce current in a copper tube, thereby heating the tube. The heater tube serves to melt the solder to trip the relay. Of course, this device depends upon ac magnetic flux and can only be used on alternating current. There are no heater elements to change, but the relay can be set to trip at any point over a wide range of current ratings, offering accurate protection to the motor controlled. The relay is adjusted by hand by changing the position of a threaded iron core to vary magnetic flux within the coil form. In this way, the heating due to induction can be adjusted to effect tripping of the relay for different values of current overload. And this same technique of induction heating can be applied to bi-metallic type running overload relays.

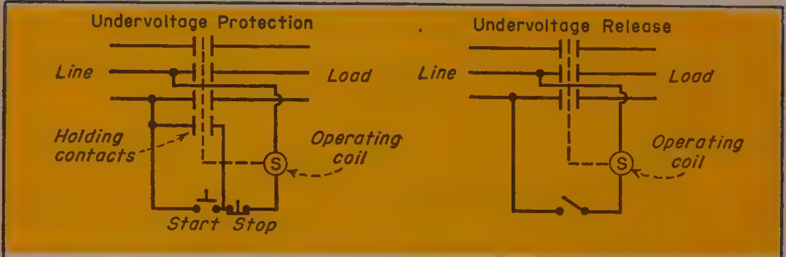
Overload protective devices of the straight thermal type are available with varying tripping and time-delay characteristics. In such devices, the heater coils are made in many sizes and are interchangeable to permit use of the required heater sizes to provide running protection for different motor full-load current ratings. In some units, the heat coil can be adjusted to exact current values. Individual covers are used on the heating elements in some starters to isolate the relay from possible effect on its operation due to temperature of surrounding air. Overload relays are made for both manual and automatic resetting after tripping.

Other Protection

In addition to running overload protection, there are two other types of protection which can be provided in the starter depending upon its hookup. These are shown in Fig. 18.

Undervoltage protection — or low-voltage protection—is the effect of a device which operates on a reduction or failure of voltage, causing and maintaining opening of the motor circuit. Such a device prevents automatic restarting of the motor upon return of voltage. As described previously, the action of a holding coil operated by momentary contact pushbuttons in conjunction with a set of holding contacts provides undervoltage protection. When voltage dips too far or fails altogether, the coil no longer holds the contacts closed; and the holding contacts open with the main contacts to break the coil circuit. When voltage has been returned, closing of the starter can be effected only by pushing the "START" button. The use of a 3-wire momentary contact pushbutton hookup, therefore, eliminates the hazard of uncontrolled restarting of a motor.

FIG. 18—For Low-Voltage or Voltage Failure



Momentary-contact pushbutton closes control circuit to actuate operating coil, closing main and holding contacts. The holding contacts keep the coil circuit closed. If the line voltage dips too low or fails altogether, the coil will not be able to hold the contacts closed. If the starter opens due to voltage failure, it cannot reclose on return of voltage. In such a case, the pushbutton must be used to again close the contacts.

A remote, maintained-contact switching device — a toggle switch, limit switch, float switch, etc. — is closed to energize the coil and close the starter. A voltage dip or loss of voltage will cause the coil to drop out the starter; but as long as the pilot switching device is closed, return of voltage will automatically re-energize the coil and close the starter. This is the "2-wire" type of remote-control circuit.

Undervoltage release — or low-voltage release—is the effect of a device which operates on a reduction or failure of voltage, causing opening of the motor circuit but not maintaining the open when voltage returns. An example of this type of protection would obtain in a starter in which the circuit through the holding coil is completed with a maintained-contact switching device. In such hookups, when the line voltage fails or drops too low, the current through the holding coil is not sufficient to hold the contacts closed and the main circuit contacts open. However, the circuit through the holding coil does not use a holding contact and is, therefore, not broken by the opening of the motor circuit. When voltage returns to the circuit, the holding coil will be immediately energized if the control circuit switching device is still in the "START" position. Although this arrangement might be objectionable in some applications because of possible hazard to personnel or equipment due to sudden restarting of the motor, it can be an advantage when a motor is to operate automatically and without the attendance of an operator. Such is the case with motor starters using maintained-contact pushbuttons or other 2-wire control circuit devices where automatic restarting is desired after a voltage dip or failure.

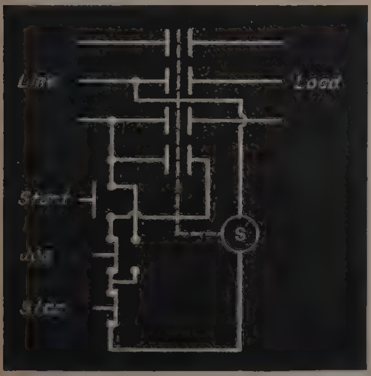
In an electrical distribution system supplying a large number of motors, undervoltage protection can afford maximum protection by prohibiting heavy currents and severe voltage dip on the system which would result from simultaneous restarting of all of the motors on the return of power. Of course, it does mean that after the return of power all of the motors must be restarted by actuating the various "START" devices; and this may be undesirable in certain plants. Time-delay relay circuits can be used in such cases to provide selective sequence restarting of motors automatically if power returns within a specified time. In systems using starters with only undervoltage release (starters with float switches or pressure switches), return of power after an outage can cause disastrous results where several large motors attempt to restart together. Time-delay relays can also be used to overcome this problem by staggered starting.

Undervoltage protection is an important consideration when the source of energy for operation of the holding coil is independent of the source of energy for the motor circuit. Of course, the same circuitry may be used as for undervoltage protection or release in the case where the coil is energized from the motor circuit. But the possibility exists of the motor circuit voltage failing while the energy supply to the coil is maintained. In such cases, the motor can stop while all control connections remain unchanged. And return of power to the motor circuit will automatically restart the motor which was not disconnected from the circuit. This action can be prevented by using an undervoltage relay in the power circuit, with contacts in series with the holding-coil circuit.

Jogging

In addition to starting and stopping a motor, another common control function is "jogging." This consists of quickly repeated closures of the circuit to energize a motor for a series of instants, to inch the rotor rotation to make very small movements of the driven machine. This is commonly used on production machinery and printing machines to align parts or to apply load at some point in the cycle of rotation. Simply, a jogging control is connected in series with the holding coil of the starter and so arranged to close the holding-coil circuit on momentary closures, as shown in Fig. 19.

FIG. 19—Basic Circuit for Jogging



Cycling or indexing is still another control function which can be accomplished through the holding-coil circuit of a starter. This control action consists of starting and running a motor for a duration necessary to accomplish a predetermined operation of the driven load, then stopping the motor.

Non-reversing, magnetic across-the-line starters for polyphase motors are made in varying sizes. Fig. 20 gives NEMA sizes and hp ratings of ac controllers based on conditions of application. Starters are available as open units or in a variety of types of enclosures to meet all conditions of application.

FIG. 20—Horsepower Ratings of AC Controllers Based on Application

	Horsepower at					
	Three Phase			Single Phase		
Size of Starter	110 volts	220 volts	440/550 volts	115 volts	230 volts	440/550 volts
0	2	3	5	1	2	3
1	3	7½	10	2	3	5
2	7½	15	25	3	7½	10
3	15	30	50	7½	15	25
4	25	50	100	—	—	—
5	—	100	200	—	—	—
6	—	200	400	—	—	—
7	—	300	600	—	—	—
8	—	450	900	—	—	—
9	—	800	1600	—	—	—

The above table gives NEMA size numbers and corresponding horsepower ratings for the following classifications of motor controllers:

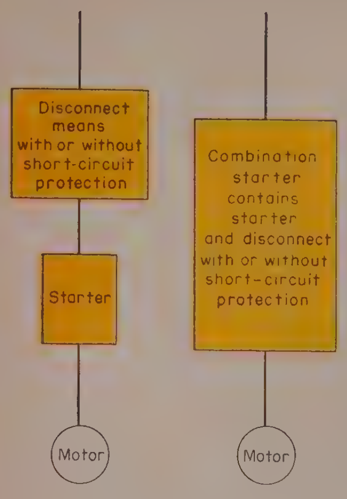
1. Reversing and non-reversing, across-the-line, magnetic starters used for non-plugging or non-jogging duty, in any type of enclosure.
2. Reversing and non-reversing, reduced-voltage, alternating-current, general-purpose magnetic starters for squirrel-cage or wound-rotor motors, in any type of enclosure. Reduced-voltage starters include: primary resistor starters, autotransformer starters and reactor starters for squirrel-cage motors, and the primary contactors of secondary resistor starters for wound-rotor motors. (Exclude Size 0 for this classification.)
3. Alternating-current magnetic controllers for use with constant-torque or variable-torque polyphase multi-speed (2, 3, and 4 speeds) motors.

	Horsepower at					
	Three Phase			Single Phase		
Size of Starter	110 volts	220 volts	440/550 volts	115 volts	230 volts	440/550 volts
0	¾	1	1	½	¾	¾
1	2	3	5	1	2	3
2	5	10	15	2	5	7½
3	10	20	30	5	10	15
4	15	30	60	—	—	—
5	—	75	150	—	—	—
6	—	150	300	—	—	—

The above table gives NEMA size numbers and corresponding horsepower ratings for the following classifications of motor controllers:

1. Across-the-line magnetic starters for single-speed motors or multi-speed motors of the constant-torque or variable-torque type, when used on duties where normal operation requires the repeated opening of stalled-rotor current. (For example, plug-stop or jogging duty which requires continuous operation with more than five openings per minute.)

FIG. 21—Combination Starters


Disconnect means with or without short-circuit protection
Starter
Motor
Combination starter contains starter and disconnect with or without short-circuit protection
Motor

Combination starters (right) accomplish same switching, protective and control functions as two units, offering economy and ease of installation in addition to assuring proper coordination between short-circuit protective device and controller. The components are closely coordinated to work together, and the unit is rated for a particular value of short-circuit interrupting duty at the point of its installation. Unit may contain a molded-case circuit breaker and a starter, or a fused or unfused switch and a starter.

Enclosure types include; general-purpose, dust-tight, water-tight, explosion-proof. The majority of starter enclosures are for wall mounting.

Magnetic starters find general application wherever remote control and/or automatic control by pilot devices are necessary. And in general, magnetic starters are better suited to frequent starting and stopping of motors than manual starting switches. Of course, one of the important advantages of magnetic starters in today's large plants is the undervoltage protection which they can provide.

Polyphase magnetic starters are designed for full-voltage starting of squirrel-cage induction motors when full starting torque and starting current surge are permitted. They are also used for primary circuit control for wound-rotor (slip-ring) motors which have provision for manual starting and speed control in their secondary circuits. Typical applications for polyphase magnetic starters include:

Automatic machine tools
Production machinery
Refrigeration machines
Air conditioning
Heating equipment.

Although the basic magnetic across-the-line starters so far described have been the polyphase type, there are single-phase magnetic starters for use with self-starting single-phase motors, permitting remote and automatic control of the motors. Such starters are generally supplied with a single thermal overload relay and heater. Typical starters of this type are rated for 120 volts or 240 volts, in sizes from 1 to 15 hp.

COMBINATION STARTERS

Basic combination starters are non-reversing magnetic across-the-line starters which incorporate a circuit breaker or a fusible or non-fusible switch in the same enclosure. The circuit breaker or switch provides a means of disconnect, as required by the code and by accepted practice. From the standpoint of control, combination starters find the same general applications as standard magnetic starters for given conditions of starting torque and current and are made in the same range of sizes, with the same types of protection for motors. From the standpoint of motor circuit operation, however, the use of combination starters varies. Application of combination starters depends upon thorough understanding of disconnect requirements.

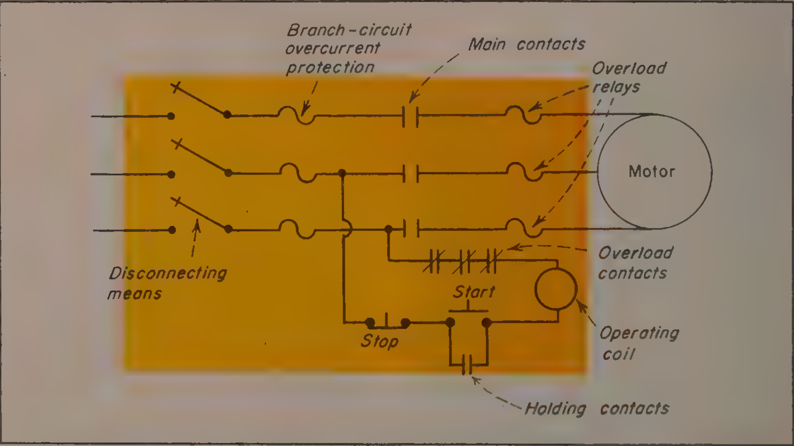
Basically, the advantage of the combination starter is its ready and convenient compliance with motor circuit requirements. This is described in Fig. 21.

In accomplishing disconnection requirements, a combination starter can frequently simplify circuit design and installation matters. For instance, where a motor circuit is tapped from a feeder and is unprotected for the allowable 10- or 25-ft run, a combination starter may be used to provide disconnect means and branch-circuit overcurrent protection for the motor circuit. Or a combination starter with an unfused switch may be used in any application where a motor branch circuit is carried out of sight of or run more than 50 ft from a distribution panel in which it originates, making the use of another disconnect desirable or necessary.

Whenever a combination starter is called for and branch-circuit protection is required for the motor circuit, the fused-switch or circuit-breaker type should be used. Fig. 22 is a typical combination assembly. The unfused-switch or circuit breaker type should be used where only disconnect means is required. Of course, in many occupancies, engineering analysis and particular conditions of equipment layout and usage will indicate uses for combination starters to provide special operating and safety advantages.

Advantages of combination starters include: neat and compact installation, reduced installation time, easier and more accurate motor circuit design, economy of relocation if necessary and safer operation. The safety feature obtains when the cover of the enclosure is interlocked with the operating handle of the disconnecting means, requiring opening of the disconnect before the enclosure can be opened. In this way, the starter and motor are dead when the enclosure door is opened. Provision is generally

FIG. 22—Combination Starter With Fused-Switch Disconnect



made for using padlocks to lock the disconnect in the "OFF" position.

Combination starters find application in motor control rooms and other places where controllers for a number of motors are neatly racked along a wall, and at machine locations when combination starters meet requirements of machine operation and maintenance and simultaneously meet circuit design requirements. Typical of such applications are large processing plants.

FIG. 23—Basic Magnetic Reversing Starter

(Running Overload Protection Not Shown)

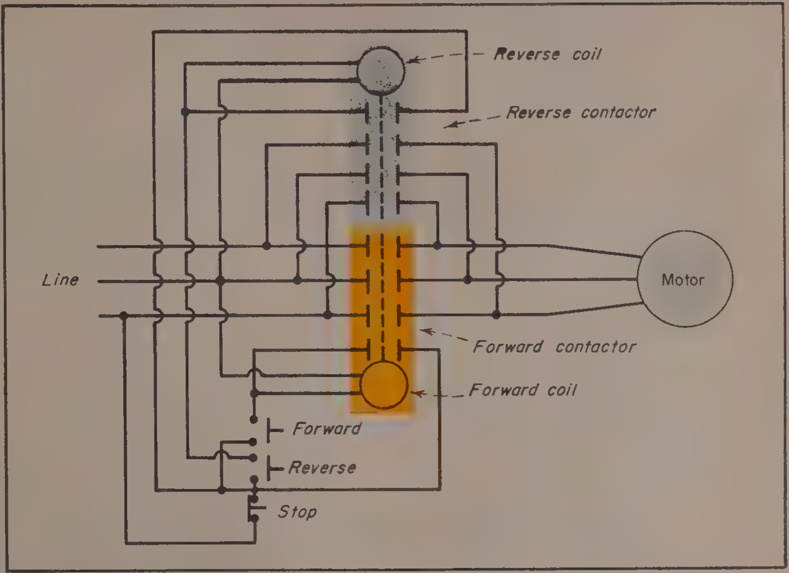
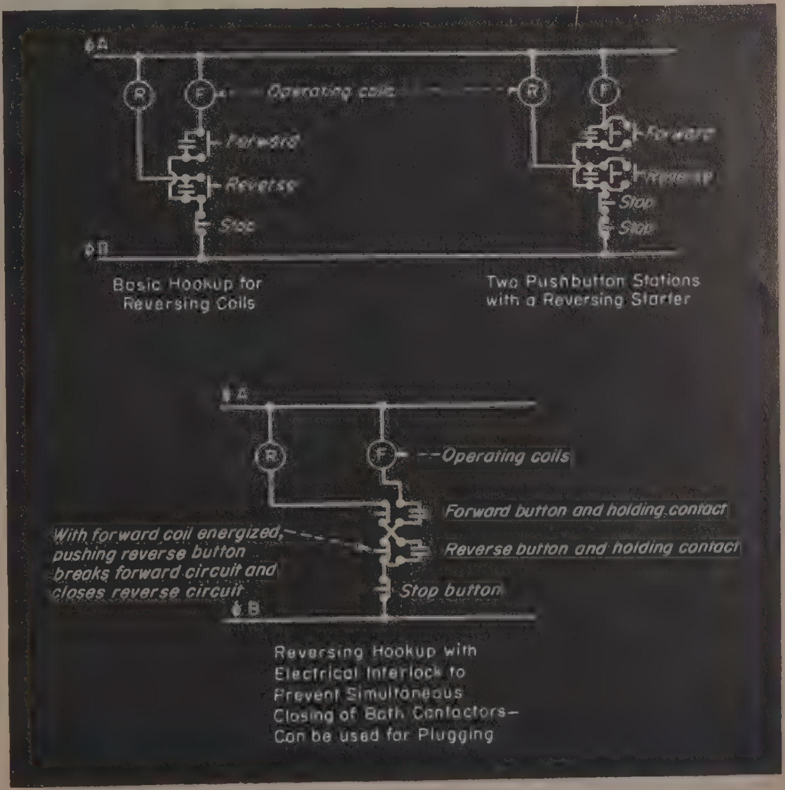


FIG. 24—Operating Coil Hookups for Reversing


φA
R
F
Operating coils
R
F
Forward
Reverse
Stop
Forward
Reverse
Stop
Stop
φB

Basic Hookup for Reversing Coils

Two Pushbutton Stations with a Reversing Starter

φA
R
F
Operating coils
Forward button and holding contact
With forward coil energized, pushing reverse button breaks forward circuit and closes reverse circuit
Reverse button and holding contact
Stop button
φB

Reversing Hookup with Electrical Interlock to Prevent Simultaneous Closing of Both Contactors—Can be used for Plugging

REVERSING STARTERS

Reversing is a frequently required motor-control characteristic. Any ac motor can usually be reversed in rotation when necessary for an application. Polyphase squirrel-cage induction motors are particularly suited to reversal of rotation by simply reversing two of the line conductors supplying the motor. This is commonly done by using two contactor assemblies—one for forward rotation of the motor, the other for reverse direction of rotation—mounted in a single enclosure.

Using a reversing starter with a suitable pushbutton hookup, when the "FORWARD" button is pushed, one of the contactors closes in such a way that the line conductors deliver voltage to the motor with a phase relationship to produce rotation in a desired direction. See Fig. 23. To reverse the direction of rotation, the "REVERSE" button must be pushed, after stopping first contactor, to close the other contactor, which reverses the phase rotation of the voltage delivered to the motor and consequently causes reversal of rotation. Depending upon the control hookup and requirements of motor usage, it may not be necessary to push a "STOP" button before reversing the motor.

On reversing controllers, interlocking of the two contactor assemblies is necessary to prevent closing of one contactor while the other is closed. This, of course, would produce short circuits on two of the phases. Both mechanical and electrical interlocking are widely used, singly or together, to protect against short circuits. Electrical interlocking circuits vary in purpose and complexity, but the basic technique consists of using normally open and normally closed contacts in both the "FORWARD" and "REVERSE" coil circuits to maintain each coil circuit open while the other is closed and to require use of the "STOP" button to stop operations of the two contactors. See bottom diagram of Fig. 24.

Reversing starters are used for across-the-line starting, stopping and reversing of polyphase squirrel-cage induction motors, for primary reversing of wound-rotor motors and for some single-phase applications. Sizes range from fractional-hp to 600 hp, up to 600 volts. Units are available with or without running overload protection of the same type as used in standard magnetic starters of corresponding sizes. And combination starters of the reversing types are available, with either a fused or unfused switch or a circuit breaker for disconnect and motor branch circuit protection against short circuits, for applications similar to those for non-reversing combination starters. A variety of enclosures meet requirements of various job conditions. Fig. 25 covers the wide range of enclosures available for all types of motor controllers.

General applications for reversing starters include: milling machines, drilling machines and bending machines.

Plugging

A particular application for reversing starters is motor plugging. Plugging is an operation by which the connection to a motor is quickly reversed, causing reverse torque on the motor to bring it to an abrupt stop. Squirrel-cage induction motors and most wound-rotor motors are capable of withstanding the shock of plugging without damage to the motor. Plugging may be used for either quick stopping or rapid reversing of motors. Using a typical reversing starter, with the motor running in one direction, if the "REVERSE" button is pushed, the connections to the motor are reversed and so is the torque. When the reverse torque stops the motor, the "STOP" button is pushed to prevent overrun. This sequence of operations is often provided by a plugging switch on the motor shaft. This is shown in Fig. 26. Of course, construction and design of the starter must be able to produce the reconnection without shorting the lines. For proper use of plugging, it must be established that the load driven by the motor can stand the strain and that the line disturbance caused by plugging is not objectionable.

FIG. 25—Enclosures for Controllers

Effective application of motor control equipment includes selection of the type of enclosure suited to atmospheric and other conditions of the occupancy in which the equipment is to be used and as required by provisions of the NEC. The following are the standard NEMA types of enclosures:

Type 1—*General Purpose:* for general purpose applications indoors and where atmospheric conditions are normal, designed to prevent accidental contact with current-carrying parts of the equipment. A Type 1 enclosure serves as a protection against dust, and light, indirect splashing but is not dust-tight.

Type 2—*Drip-Tight:* similar to general purpose type, with shields protecting against dripping, constructed as to exclude falling moisture or dirt. A Type 2 enclosure is suitable for application where condensation may be severe such as is encountered in cooling rooms and laundries.

Type 3—*Weather-Resistant:* for use where exposed to rain or sleet and on docks, canal locks and in subways or tunnels.

Type 4—*Watertight:* for use outdoors or where equipment might be subjected to splashing or dripping water. A Type 4 enclosure is suitable for application outdoors on ship docks and in dairies, breweries, etc.

Type 5—*Dust-Tight:* prevents entry of dusts into controllers used in such non-hazardous areas as cement mills, steel mills and coke plants—where dust or lint would interfere with operation of the controller.

Type 6—*Submersible:* for use where the unit might be submerged in water, as in mines, quarries and manholes.

Type 7—*Hazardous Locations:* for use in Class I, Groups A, B, C or D hazardous locations—containing hazardous gases.

Type 8—*Hazardous Locations:* similar to Type 7, except that contacts are immersed in oil, for use where hazardous gases are corrosive.

Type 9—*Hazardous, Dust-Tight:* for use in Class II, Groups E, F and G hazardous locations such as flour mills and grain elevators.

Type 10—*Bureau of Mines:* for use in coal mines. This enclosure is designed to meet the explosion-proof requirements of the U. S. Bureau of Mines. It is suitable for use in gassy coal mines.

Type 11—*Corrosion-Proof:* for use where equipment is exposed to corrosive acid or fumes, as in chemical plants, plating rooms, etc.

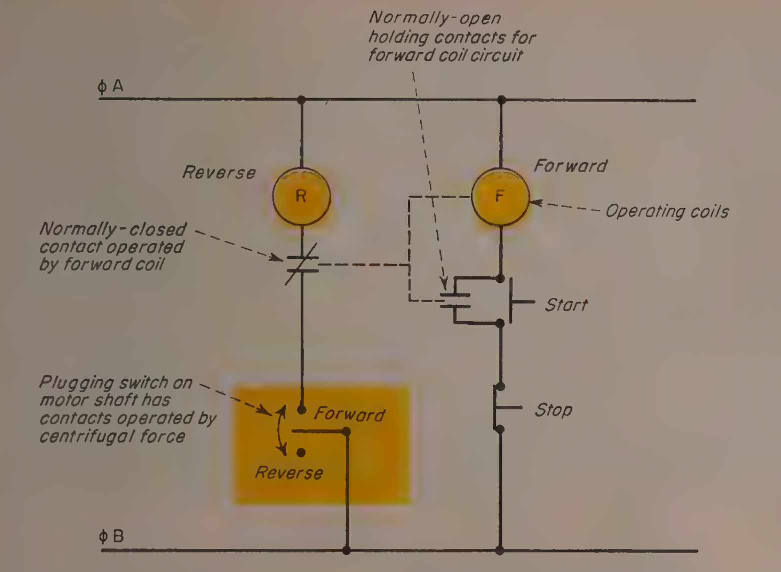
Type 12—*Industrial Use:* designed for use in automotive and other industrial plants, to protect equipment against dirt and oil by preventing seepage or infiltration and keeping lint, fibers and flyings out of the controller. This new type of enclosure has found wide application as a substitute for Type 1 enclosures and is mandatory in the JIC Electrical Standards for Industrial Equipment.

MULTI-SPEED CONTROLLERS

Full-voltage magnetic starters are available for operating multi-speed motors at different speeds. A typical multi-speed starter consists of a group of contactor assemblies in a single enclosure, each contactor operating the motor at one speed. Units are available for two, three and four speeds.

Given a fixed frequency of the ac supply voltage, the speed of rotation of a 3-phase motor depends upon the number of poles in the motor. Speed is decreased by an increase in the number of poles. If, then, the number of poles in a 3-phase motor was changed, the motor would rotate at a different speed. This is the principle on which multi-speed ac motors are based. Multi-speed squirrel-cage induction motors may have one winding which can be reconnected to produce a different number of poles, or it may have separate windings to produce different numbers of poles. In the former case, the winding is a "consequent-pole" type and can be reconnected to obtain two different numbers of poles, with speeds in a ratio of 2-to-1. In the case of separate windings, each winding produces a certain number of poles for a certain speed, but the two speeds do not have to be in the ratio of 2-to-1. And if one or both of the sep-

FIG. 26—Automatic Plugging with Reversing Starter


ϕA
Normally-open holding contacts for forward coil circuit
Reverse
R
F
Forward
Operating coils
Normally-closed contact operated by forward coil
Start
Plugging switch on motor shaft has contacts operated by centrifugal force
Forward
Reverse
Stop
ϕB

A reversing starter is here connected for non-reversing plugging of a motor. Motor is started in forward direction by "START" button, closing holding contacts and opening interlock contacts in reverse coil circuit. When "STOP" button is pressed, the forward circuit is opened and the reverse circuit is closed through the normally-closed interlock contacts and through the contacts on the plugging switch. The plugging switch contacts are closed in the forward position by centrifugal force of forward motor rotation. As a result, as soon as the "STOP" button is pressed, reverse torque is applied to the motor to "plug" it to a stop. As the motor rotation slows down, the centrifugal force becomes insufficient to keep the plugging switch contacts closed. The plugging switch contacts open when the rotating speed is near zero. Modifications on this basic hookup can be used for reversing duty and for plugging-or-coasting stops.

FIG. 28—Horsepower Ratings for Constant-Horsepower Multi-Speed Controllers

Size of Con-tactor	Horsepower Ratings 110 volts	220 volts	440/550 volts
0	1	1½	2
1	1½	3	5
2	5	10	20
3	10	20	40
4	15	30	60
5	—	75	150
6	—	150	300
7	—	225	450
8	—	350	700
9	—	600	1200

The above table gives NEMA size numbers and corrseponding horsepower ratings for alternating current magnetic controllers for use with constant-horsepower polyphase multi-speed (2, 3, and 4 speeds) motors.

Size of Starter	Horsepower at 110 volts	220 volts	440/550 volts
0	¾	1	1
1	1½	3	5
2	5	10	15
3	10	20	30
4	15	30	60
5	—	75	150
6	—	150	300

The above table gives NEMA size numbers and corresponding horsepower ratings for across-the-line magnetic starters for constant-horsepower multi-speed three-power motors when used for plug-step jogging duty.

FIG. 27—Torque Data on Multi-Speed Motors

Torque characteristics possible divide multi-speed motors into three general groups, each with definite type of application:

1. **Constant torque** motors have horsepower that varies directly with speed. For example, a motor of this type rated 10 hp at 1800 rpm will deliver 5 hp at 900 rpm. Uses include feeders, mills, conveyors, etc.
2. **Variable torque** motors have horsepower output varying as square of speed. They are applicable only to drives having fan or centrifugal pump load characteristics.
3. **Constant horsepower** motors deliver rated horsepower at any of the speeds for which motor is designed, while torque varies inversely as speed. They are used for applications such as machine tools where motor speed governs speed of cutting tool.

FIG. 29—Multi-Speed Controller for Two-Speed Single-Winding Motor Providing Constant Torque at Both Speeds

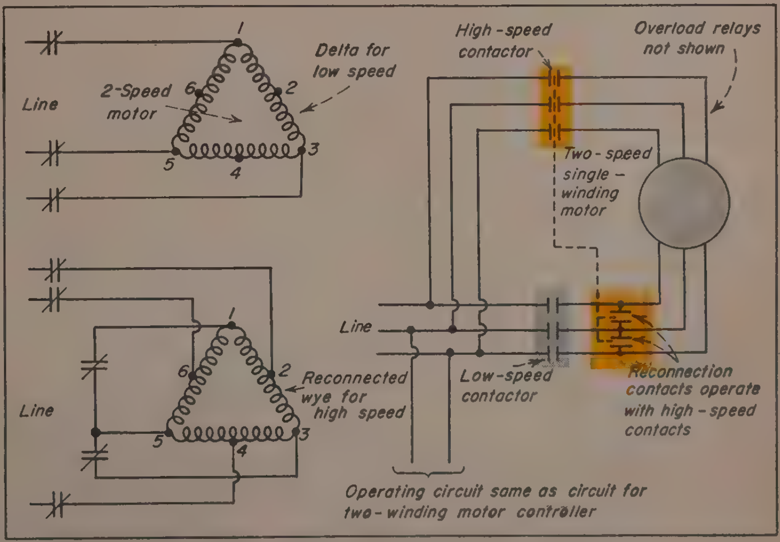
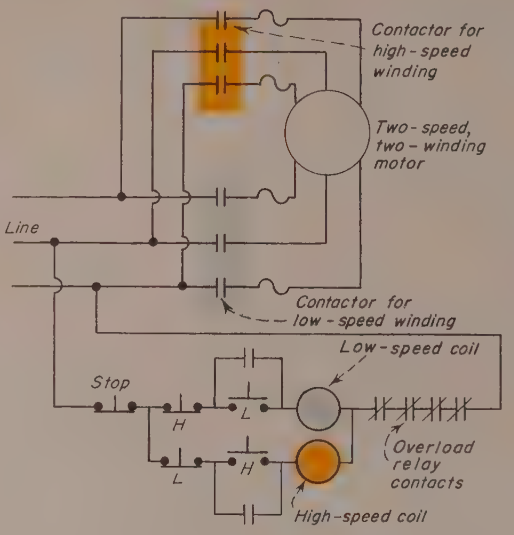

Line
2-Speed motor
1
2
3
4
5
6
Delta for low speed
High-speed contactor
Overload relays not shown
Two-speed single-winding motor
Line
Line
Reconnected wye for high speed
Low-speed contactor
Reconnection contacts operate with high-speed contacts
Operating circuit same as circuit for two-winding motor controller

FIG. 30—Multi-Speed Controller for Two-Speed, Two-Winding Motor

When button "L" is pressed, the low-speed winding is connected to the line and the holding contacts across the button will hold the circuit closed after release of the button. To change to high speed, the button "H" is pressed, breaking the circuit to the low-speed contactor and closing the circuit to the high-speed contactor. The motor then runs at the high speed. Such controllers can be equipped with relays to provide automatic, timed transfer from low speed to high speed.

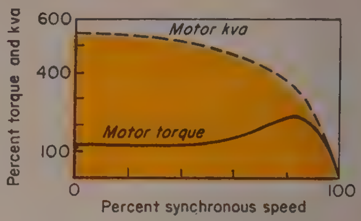

Contactor for high-speed winding
Two-speed, two-winding motor
Line
Contactor for low-speed winding
Low-speed coil
Stop
H
L
L
H
Overload relay contacts
High-speed coil

arate windings on the stator are of the consequent-pole type, then the motor may operate at three of four speeds. The torque characteristics of such multi-speed motors are covered in Fig. 27.

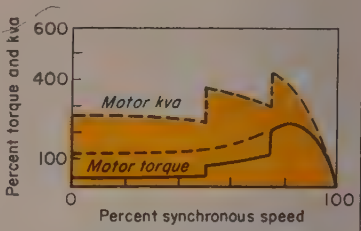
Multi-speed starters for constant hp, constant torque or variable torque are available in many sizes as shown in Fig. 28, and are equipped with various relay arrangements to provide starting and automatic speed control according to load requirements.

To provide selection of any desired speed for the types of multi-speed motors described above, a multi-speed starter connects the supply line to the required winding terminals. The controller will provide for change of connections in the case of consequent-pole motors and for change of winding in the case of two-winding motors. See Figs. 29 and 30. The contactors are interlocked to prevent short circuits, and the starters are equipped with running overload protection for use at each speed. They can be used for remote control.

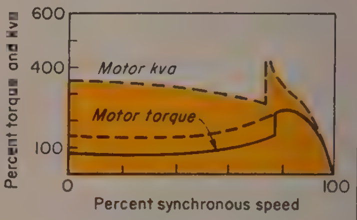
FIG. 31—Comparison of Starting Methods for Full-Load Motor Torque and KVA



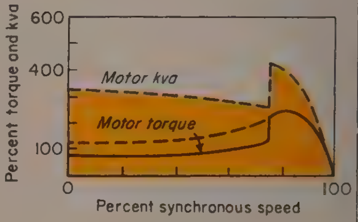
FULL-VOLTAGE STARTER



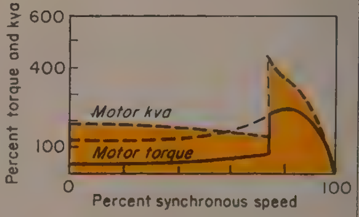
REDUCED-VOLTAGE RESISTANCE STARTER, THREE POINTS OF ACCELERATION



REDUCED-VOLTAGE AUTOTRANSFORMER WITH TWO WINDINGS



PART WINDING STARTER



STAR-DELTA STARTER

REDUCED-VOLTAGE STARTING

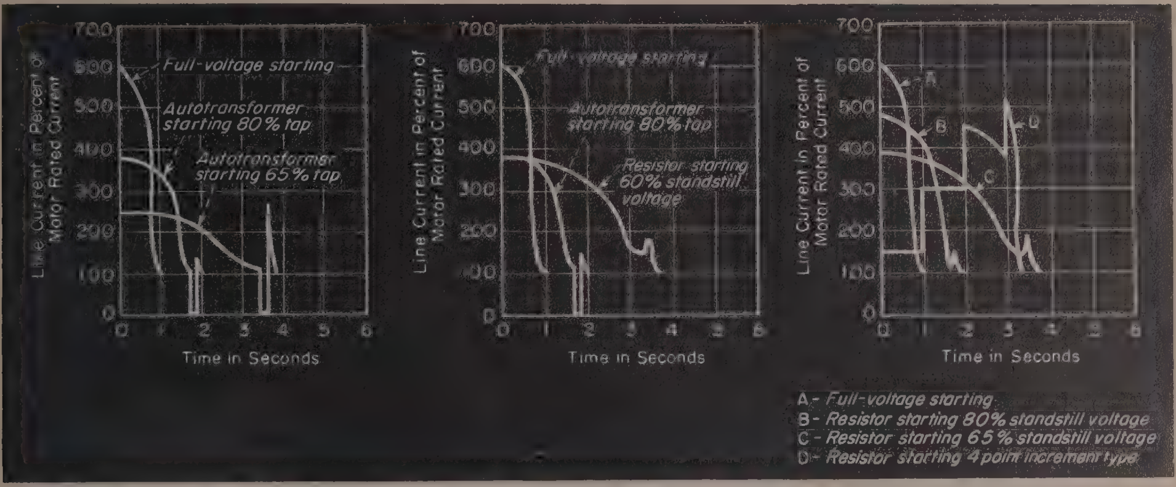
Full-voltage starting of motors can in many cases produce objectionable results. In cases where the supply system does not have the capacity to meet the current requirements, line voltage disturbances can be severe. Motor and other loads on the system are adversely affected. And the high current drawn may actuate protective devices and throw the system out of service. Where the use of full-voltage starting would burden the distribution system and/or where the driven equipment or the work cannot take high starting current and torque, reduced-voltage starters are used. Such starters vary according to principle of operation or application. Figs. 31 and 32 compare current, torque and speed characteristics of full-voltage starting and various reduced-voltage methods.

PRIMARY-RESISTOR STARTING

The easiest way to start a motor at reduced voltage is to connect a resistor in series in each conductor to the motor. The starting current is thereby reduced, and the resistors can be removed when the motor has come up to a certain speed. The motor then runs on full line voltage. This method is used in primary resistor starters.

Manual primary resistor starters are used for polyphase squirrel-cage motors and have manual provision for removing the starting resistance after the motor starts accelerating. In a typical rheostat-type

FIG. 32—Typical Starting Characteristics of a Squirrel-Cage Motor
(Driving a Loaded Pump)



manual unit, tapped resistance elements are connected in series in two of the three phases. An operating arm on the starter is pivoted at its mid-point and has its two ends insulated from each other. As it is rotated from the "START" to "RUN" positions, a contact under each end of the arm wipes across contacts connected to taps on one of the resistor elements. Moving the arm cuts out equal sections of resistance in each of the two phases until the motor is supplied at full voltage. Some such units use a holding coil to keep the arm at the point of resistor-short once the motor is going. Other units may be used with intermediate positioning of the arm to allow speed control.

Another type of manual primary resistance starter uses series resistance elements which are varied in value by compression. In a typical starter of this type, a handle on the side of the enclosure is used to control compression of graphite discs in the resistors. In this way the resistance value is varied; and smooth, stepless control of the starting current is obtained. As the handle is raised to the "ON" position, the resistance in series with the lines is gradually reduced to zero, at which point a magnetic contactor connects the motor to the line, as shown in Fig. 33. The handle then returns to the "OFF" position. A "STOP" button mounted in the cover of the enclosure is used to open the circuit to stop the motor. The unit has running overload and no-voltage protection. Starters are made up to a few hundred hp.

AUTOMATIC RESISTANCE STARTERS

Automatic primary resistance starters perform the same function as manual resistance starters, except that the introduction and removal of resistance for starting is done automatically. A typical unit contains one contactor which connects the motor to the three line conductors through three resistors to start. After a definite time delay, when the motor has reached speed, another contactor closes and shorts out the starting resistors. This is illustrated in Fig. 34. Because primary resistance starters are generally used with small and medium sizes of motors, the time delay does not have to be long. Units are available with resistors of different duty ratings to meet varying requirements of loads.

For larger sizes of motors, above 200 hp, one type of primary resistor starter delivers reduced voltage to a motor through resistors which are short-circuited in steps at various intervals. This type of starter is called a "multi-point" resistor starter. Another type of automatic resistor starter provides automatic, stepless reduction of series resist-

FIG. 33—Manual Resistance-Type Starter

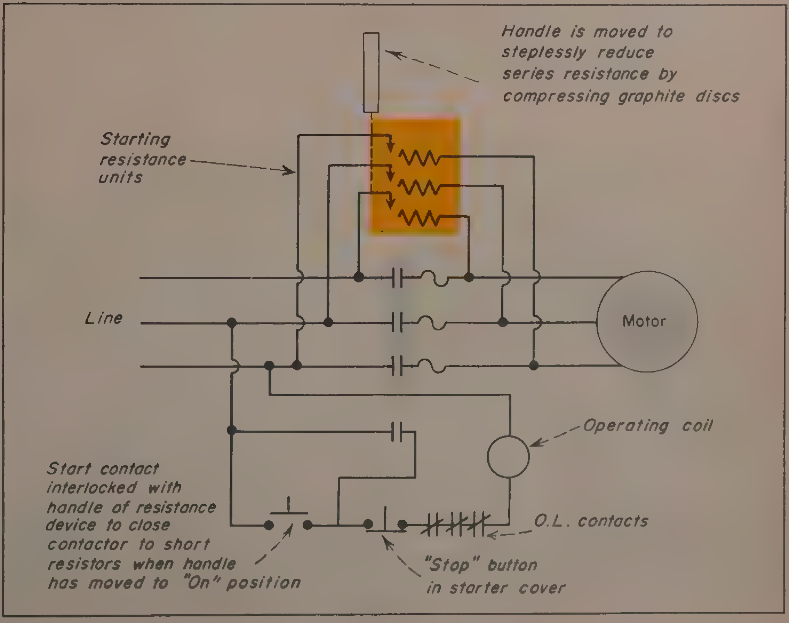

Handle is moved to steplessly reduce series resistance by compressing graphite discs
Starting resistance units
Line
Motor
Operating coil
Start contact interlocked with handle of resistance device to close contactor to short resistors when handle has moved to "On" position
O.L. contacts
"Stop" button in starter cover

FIG. 34—Automatic Reduced-Voltage Starter Using Primary Resistance for Two-Point Acceleration

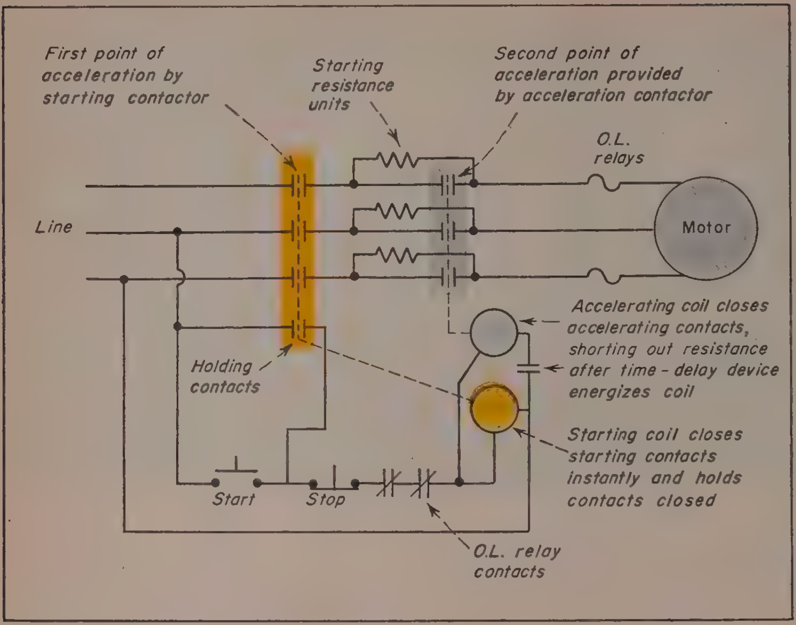

First point of acceleration by starting contactor
Starting resistance units
Second point of acceleration provided by acceleration contactor
O.L. relays
Line
Motor
Accelerating coil closes accelerating contacts, shorting out resistance after time-delay device energizes coil
Holding contacts
Starting coil closes starting contacts instantly and holds contacts closed
Start
Stop
O.L. relay contacts

FIG. 35—Switching Operations in an Autotransformer Starter (For Manual or Automatic Operation)

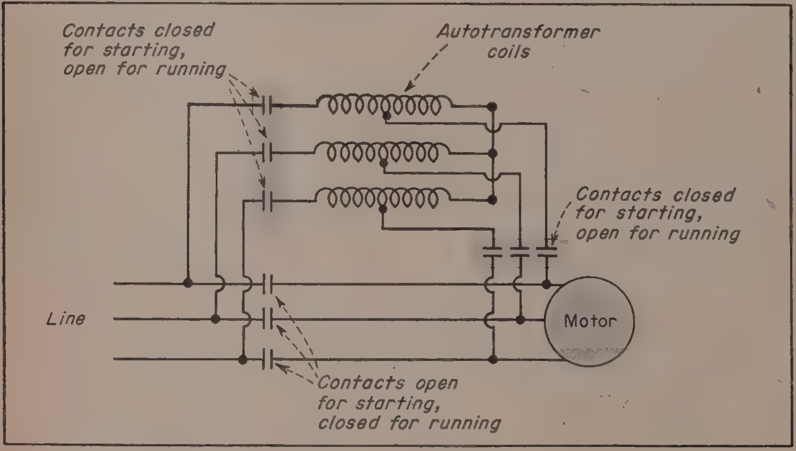
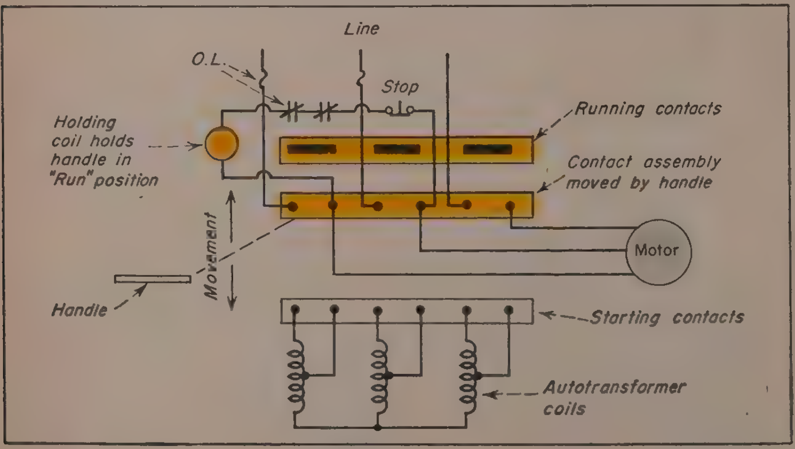

Contacts closed for starting, open for running
Autotransformer coils
Contacts closed for starting, open for running
Line
Motor
Contacts open for starting, closed for running

FIG. 36—Manual Autotransformer Starter (Three coils in wye)



ance for applications requiring very smooth acceleration to minimize system disturbances and to prohibit shock to the driven load.

In addition to resistance, inductive reactance can be used in series with the line conductors to provide reduced voltage to motors. The application of reactors is essentially the same as that of resistors.

Using resistors or reactors for motor starting, starting current is directly proportional to the voltage taps. This differs from the use of autotransformers for starting, in which the percent of current is lower than the percent of voltage tap. Autotransformers provide better current limiting on in-rush.

AUTOTRANSFORMER STARTING

In general, the most widely used type of reduced-voltage starter for polyphase squirrel-cage motors is the autotransformer or compensator type of starter, offering current limiting and higher starting torque per amp than other reduced-voltage starters, without the energy loss of resistor type starters. These starters use transformer action to obtain reduced voltage, as shown in Fig. 35, and are made for manual or automatic operation.

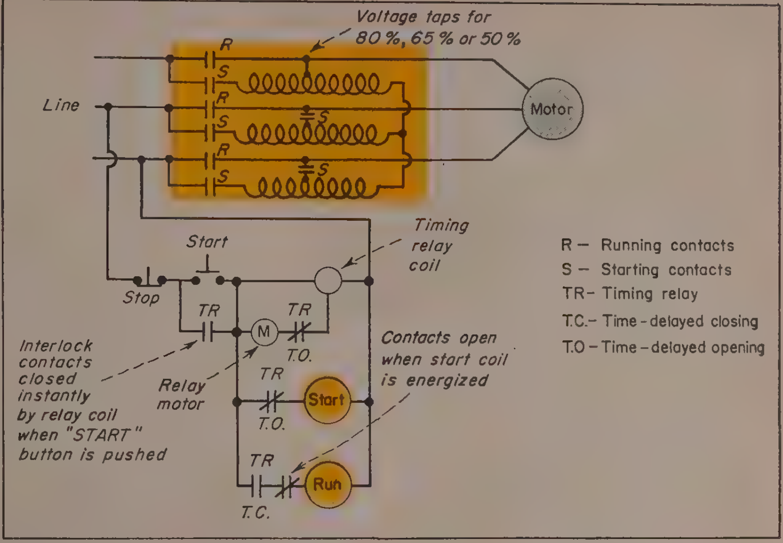
A typical manual autotransformer starter consists of three autotransformer coils—one in each line conductor—contact assemblies, protective devices and an operating handle. Each autotransformer coil is generally tapped at one or more points along its winding. The autotransformers are connected in wye and connected to the motor in such a way as to supply reduced voltage to the motor when the line is closed through the autotransformers. Several sets of taps are usually brought out to provide different values of reduced voltage (in % of line voltage) for starting. The voltage tap used should provide required starting torque at minimum current. To operate, the handle is moved to the "START" position, held there for a few seconds (or until a bell rings in some units), and then moved to the "RUN" position to apply full line voltage to the motor. In this operation, the motor is first connected to the reduced voltage available at the taps of the autotransformers. Then when the motor has started and the initial current inrush has ceased, the autotransformers are cut out of the circuit. See Fig. 36.

The connections involved for starting and running positions in the starter are accomplished by an air-break or oil-immersed switching mechanism. In those cases where the switching contacts can withstand the arcing which results when the motor is disconnected from the autotransformer in air and connected across the line, air break switching can be used. In other cases, particularly the larger sizes, oil-immersed switching is used to squelch the arc.

In the manual autotransformer starter described, a holding coil is used to hold the handle in the "RUN" position. This coil is in series with running overload relays (actuated by heaters in the line side of the starter) and a "STOP" button across two of the motor terminals. Use of the "STOP" button, opening of the overload relays or undervoltage on the coil will release the spring-returned operating handle to the "OFF" position, opening the starter.

Although the foregoing covers a starter with three autotransformer coils, other compensator type starters use only two autotransformer coils. In such starters, each of two autotransformers is connected in series with one of the line conductors. The third line conductor connects directly to the motor. On starting, this is equivalent to an open-delta connection, with a reduced voltage supplied to the motor. When the motor has accelerated, the changeover in switch connections is made to the "RUN" position where the holding coil takes over to hold the handle.

FIG. 37—Automatic Autotransformer Starter (Open transition)


Voltage taps for 80 %, 65 % or 50 %
R
S
R
S
R
S
S
S
Line
Motor
Timing relay coil
Start
Stop
TR
TR
T.O.
Interlock contacts closed instantly by relay coil when "START" button is pushed
Relay motor
M
TR
T.O.
Start
Contacts open when start coil is energized
TR
T.C.
Run
R — Running contacts
S — Starting contacts
TR — Timing relay
T.C. — Time-delayed closing
T.O — Time-delayed opening

MAGNETIC AUTOSTARTER

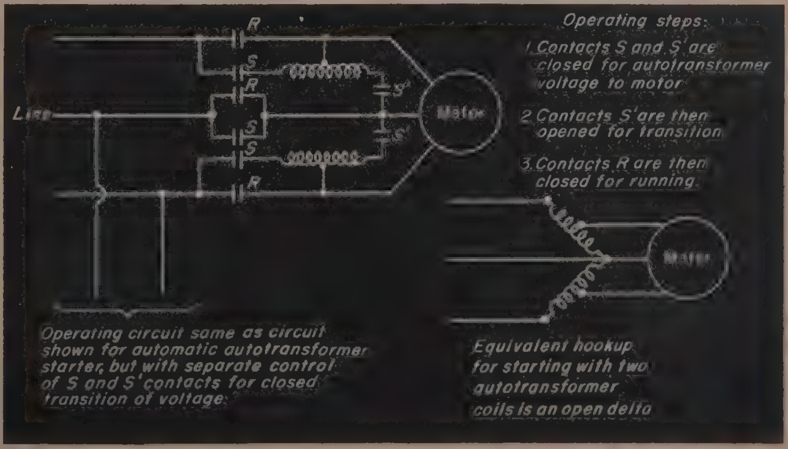
Automatic autotransformer type starters are generally similar to the manual autotransformer starter. In the automatic unit, however, the switching operations are made by magnetic contactors in combination with a timing device. The timing device initiates the transfer from reduced voltage to full voltage. Typical operation is as follows:

The coil of the starting contactor is energized to connect the motor to the reduced voltage taps of the autotransformer. After a time delay to allow the motor to accelerate at reduced voltage, the timing device opens the starting coil circuit, breaking the starting contacts, and closes the coil circuit to the running contactor which connects the motor to the full line voltage. In one typical starter, the timing device is an adjustable, motor-operated timing relay. It is set into operation when the "START" circuit is closed, and after a definite period the motor opens the starting circuit and closes the running circuit. Such a circuit is shown in Fig. 37. Adjustable pneumatic timing relays and other types of timing relays are also used.

Automatic autotransformer starters are available with two coils connected in open delta, as in Fig. 38, or with three coils connected in wye. Two-coil starters produce a usually negligible unbalance in starting voltages. As in the manual types, autotransformer taps are provided to adjust the value of reduced voltage to meet various requirements for starting current and torque. The big advantage of the automatic type of autotransformer starter is that it can be used with remote-control pilot devices.

In addition to being classified according to type of coil connection—i.e., three coils in wye or two coils in delta—autotransformers can also be divided into two types based on the manner in which transition is made from reduced voltage to full voltage. Figs. 36 and 37 show units which provide "open-transition" starting, i.e., the supply conductors to the motor are completely opened or broken in going from reduced voltage to full voltage. Fig. 38 shows a unit with "closed-transition" starting, i.e., the supply circuit to the motor is not opened in going from reduced voltage to full voltage. Closed-transition starting introduces another step in the operation and eliminates the second inrush current which occurs in

FIG. 38—Closed-Transition Starting (Two coils in delta)



Operating steps:
1. Contacts S and S' are closed for autotransformer voltage to motor
2. Contacts S' are then opened for transition
3. Contacts R are then closed for running

Operating circuit same as circuit shown for automatic autotransformer starter, but with separate control of S and S' contacts for closed transition of voltage

Equivalent hookup for starting with two autotransformer coils is an open delta open-transition starting when the supply circuit is closed in the full-voltage position.

Autotransformers used in these starters have certain characteristics which suit them to various applications. To provide for requirements of different loads and frequencies of starting, the autotransformers are rated for heavy-duty, medium-duty and light-duty applications. The range of commonly available voltage taps on the autotransformers provides for varying loads.

Careful application of autotransformer starters is essential to assure satisfactory operation of the motor and the controller and to assure maximum realization of the benefits of reduced-voltage starting. For any application, the autotransformer tap selected for use should supply the motor with the lowest value of voltage sufficient to bring the motor to full speed before the changeover is made to full voltage operation. The low-voltage tap will minimize starting current. But the voltage must bring the motor to full speed before transfer to full voltage occurs. If transfer to line voltage is made before the motor has attained full speed, the current drawn from the line will be much higher than the current drawn at starting with reduced voltage. Such operation produces objectionable arcing in the contact assembly and can create serious line disturbances. Adjustment of transfer timing and use of voltage tap should provide a starting current as low as possible, with a current at transfer that does not exceed the starting current.

PART-WINDING STARTERS

A part-winding starter is an automatic type of starter for use with squirrel-cage motors which have two separate, parallel windings on the stator. The starter contains two magnetic contactors, each of which is rated for half the motor hp and is used to supply one winding. In operation, one contactor is closed to connect the line to one of the motor windings. After a short time delay, a time-delay relay actuates the other contactor which connects the other motor winding to the line. See Fig. 39. With this operation, the starting current is effectively reduced in a manner similar to a reduced-voltage starter. However, the available starting torque of the motor limits the use of this starter.

Part-winding or increment starters are available in sizes up to 400 hp, 600 volts. Two-step part winding starters bring the motor up to speed in two steps—first, operation of the starting contactor; and then operation of the second contactor. Three-step starters use resistance in series on the first step, then remove the resistance and connect the second winding for full-load operation.

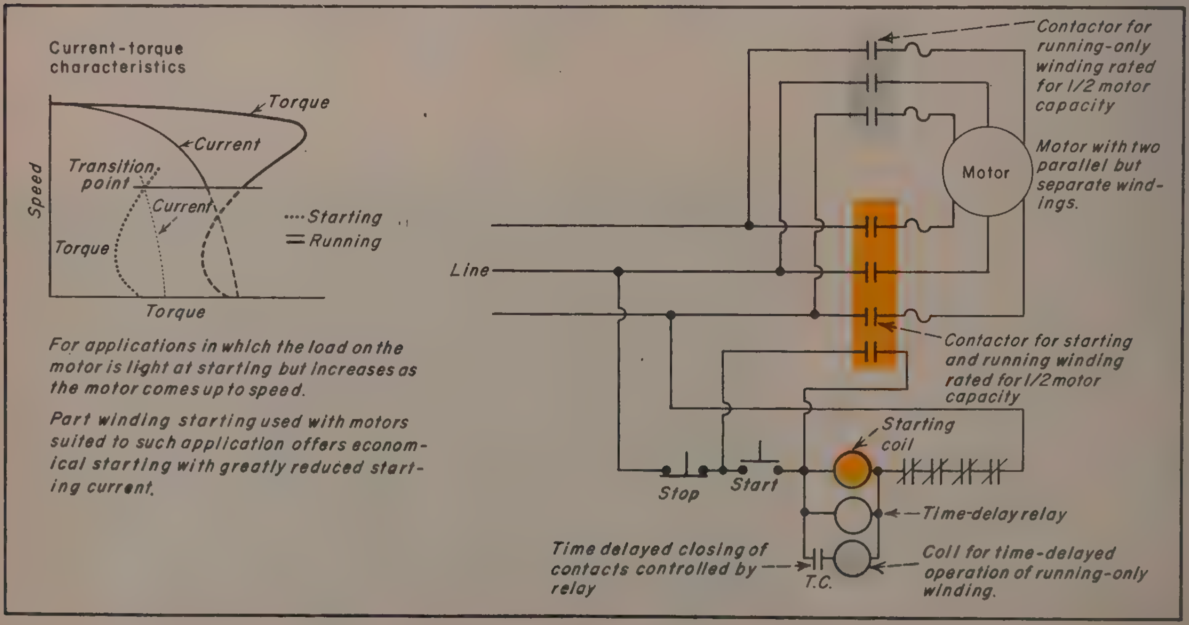
Part-winding starters do not disconnect the motor from the line at any time, eliminating any shocks to the system or machinery. They provide smooth acceleration and steady application of power to the motor, and should be used where small increments of starting torque are required by the load and/or where it is required to maintain small increments of starting current. These starters can be used with momentary contact pushbuttons for remote-control applications.

Fig. 40 shows the use of star connection on starting of delta-connected motors, to produce reduced-voltage starting.

DRUM SWITCHES

Drum switches and controllers are made in a number of types for various ac and dc motor-control applications. They often provide the best means of reversing or controlling speed of small ac motors in cases where frequent switching is required and the controller is to be located close to the operator—such

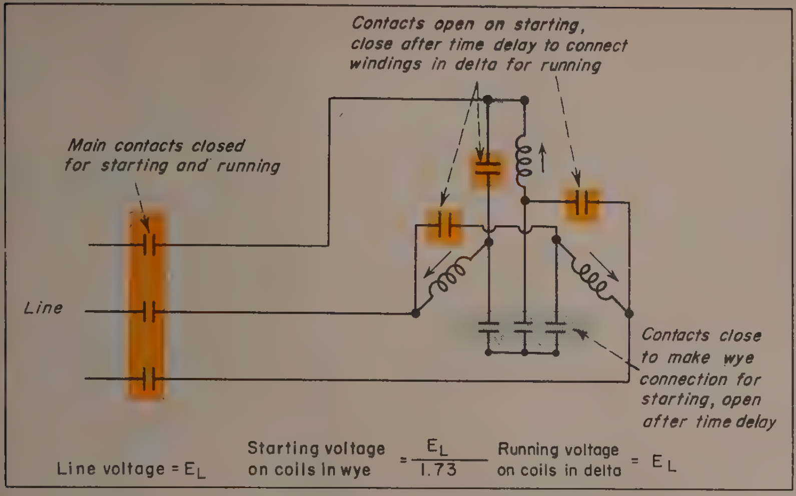
FIG. 39—Two-step Part-Winding Starter for Motors With Two Parallel Stator Windings


Current-torque characteristics
Torque
Current
Transition point
Speed
Current
Torque
····Starting
═ Running
Torque
Line
Contactor for running-only winding rated for 1/2 motor capacity
Motor
Motor with two parallel but separate windings.
Contactor for starting and running winding rated for 1/2 motor capacity
Starting coil
Stop
Start
Time-delay relay
Time delayed closing of contacts controlled by relay
T.C.
Coil for time-delayed operation of running-only winding.

For applications in which the load on the motor is light at starting but increases as the motor comes up to speed.

Part winding starting used with motors suited to such application offers economical starting with greatly reduced starting current.

FIG. 40—Star-Delta Method of Starting Delta-Connected Motors on Reduced Voltage


Contacts open on starting, close after time delay to connect windings in delta for running
Main contacts closed for starting and running
Line
Contacts close to make wye connection for starting, open after time delay
Line voltage = E_L
Starting voltage on coils in wye = $\frac{E_L}{1.73}$
Running voltage on coils in delta = E_L

as on lathes and other machine tools. Drum switches consist basically of a vertical cylindrical drum which is mounted in an enclosure to permit revolution of the drum by means of a handle on top. Contact segments are mounted on the drum in such a way that they touch stationary sliding-contact fingers as the drum is rotated. The number of contacts and other internal arrangements of a drum starter depend upon the service for which it is made. Drum switches are used as follows:

Reversing drum switches—are used for manual starting and reversing duty on small squirrel-cage 3-phase motors, single-phase motors capable of reversing service and on shunt- and compound-wound dc motors. Such switches used for reversing duty simply provide reversal of two line connections to a 3-phase motor, as shown in Fig. 41. Units are available with spring-return action to center the handle in the "OFF" position unless it is manually held in a running position, or without spring-return action to permit maintained positioning of the handle in either running position. And units are available with simple and quick means for on-the-job change from momentary to maintained contact, or vice versa, without need for any tools.

These switches are available with various interlock contacts for use with magnetic starters. In one case, interlock contacts which close in either running position can tie the switch into a holding-coil circuit. Another type of interlock permits operation of the magnetic starter by means of contacts in the drum switch, combining operation of the starter with that of the switch. Ratings of reversing drum switches run to 40 hp, 600 volts.

Speed control drum switches—are used for manual starting, reversing and speed control of polyphase, multi-speed motors, of either the separate-winding or consequent-pole type—for variable torque, constant torque or constant horsepower applications. A typical application is shown in Fig. 42. Units are made for two, three or four speeds, for reversing at one or all speeds or for non-reversing, in either open construction for use in machines or in enclosures. Several types of interlocks are available for use with magnetic contactors, and a pushbutton station in a drum-switch enclosure can provide for operation of a magnetic starter. Drum switches of this type are available up to 150 hp, 600 volts.

Design of motor control circuits using drum switches for the foregoing applications must include provision for running overload protection and, where required, undervoltage protection or undervoltage release. Drum switches are made with built-in overload relays. When drum switches do not contain overload relays, they are commonly used in conjunction with standard manual or magnetic motor starters to obtain the necessary running protection for the motor.

FIG. 41—Drum Switch for Reversing of Small Motors

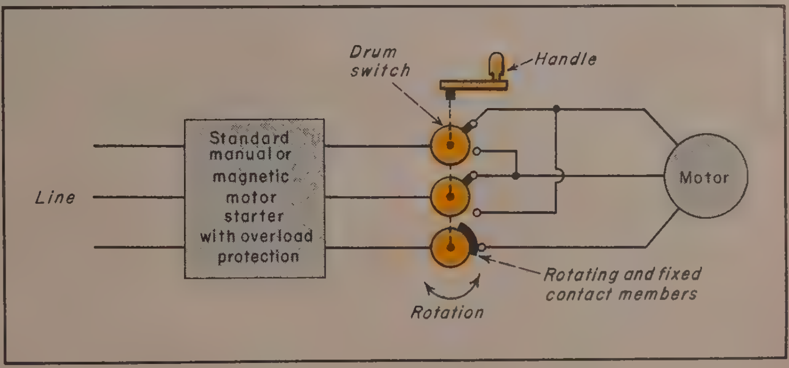
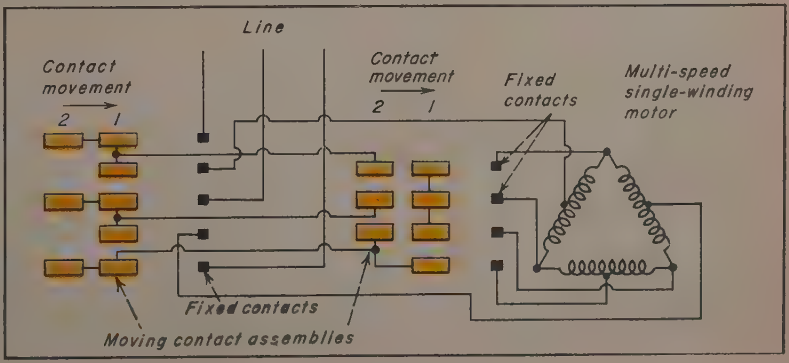

Drum switch
Handle
Line
Standard manual or magnetic motor starter with overload protection
Motor
Rotating and fixed contact members
Rotation

FIG. 42—Drum Switch for Control of Multi-Speed Motor, Constant HP (Wye—Low Speed; Delta—High Speed)



WOUND-ROTOR CONTROL

The wound-rotor or slip-ring induction motor has a rotor winding made up of conductors set in the slots and connected to three slip rings mounted on the shaft and insulated from each other at one end of the rotor. Brushes are used to make contact with these slip rings to complete the rotor circuit through resistors external to the motor. This type of motor is widely used where some measure of speed control is required, where high starting torque with low starting current and minimum line disturbance is desired, and/or where fast acceleration or frequent starting is needed.

For starting, accelerating and regulating the speed of wound-rotor motors, resistance is inserted in the external rotor circuit. The slip rings are connected to resistance units in each phase of the rotor circuit. Such a motor is started with all of the resistance value in the rotor circuit, minimizing starting current. As the motor begins to accelerate, the resistance value is reduced step-by-step until all of it is short circuited. The successive reductions in resistance values produce a series of speed-torque conditions in the motor, as shown in Fig. 43. With all of the resistance shorted out, the motor operates as a squirrel-cage motor. Wound-rotor motors are used for such applications as: large conveyor systems, centrifugal blowers, crane hoists, mill tables and for general mill service.

The basic control circuit for a wound-rotor motor consists of a full-voltage starter to connect the motor stator to the primary supply circuit and a balanced, adjustable, 3-phase resistor, wye-connected in the rotor circuit. See Fig. 44. The primary starter may be a manual switch or an across-the-line magnetic starter with running overload and under-voltage protection. The secondary resistance starter may be a manual device for gradually reducing the resistance in the rotor circuit or it may be a magnetically operated contactor for cutting out the resistance. For speed control, increase of resistance in the rotor circuit produces decreases in motor speed.

Using a magnetic full-voltage starter for primary control of a wound-rotor motor affords ready electrical interlocking with the secondary controller. Interlock contacts on the secondary starter can be connected in series in the primary-starter operating-coil circuit and arranged to permit operation of the primary contactor only if all of the secondary resistance is in the secondary circuit.

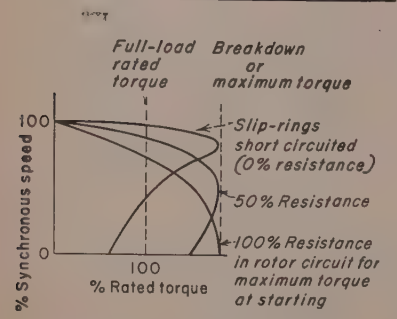
A typical magnetic-type starter for non-reversing use with wound-rotor motors is shown in Fig. 45 and usually includes the following elements:

1. A line contactor for the primary supply circuit.
2. Timed accelerating contactors for short circuiting the starting resistors.
3. Starting resistors.
4. Running overload protective relays.

In such a starter, the starting resistors may be mounted in the enclosure. In the larger sizes, the resistors are generally mounted separately. Mounting of the resistors depends upon the application and duty-service. Starters of this type are available in ratings up to 600 volts and for high-voltage applications, in a number of different types of enclosures.

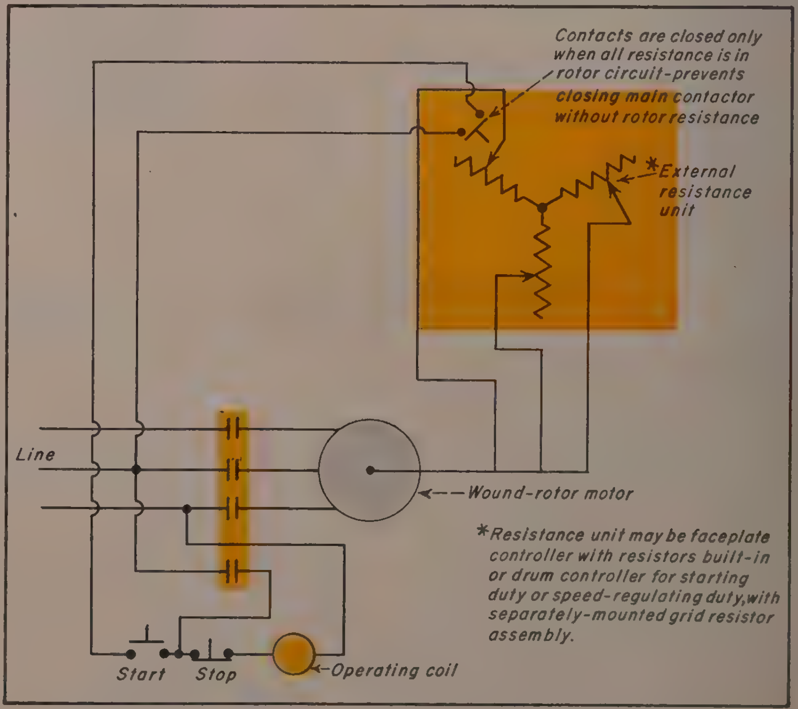
A special form of resistor and reactor starter for a wound-rotor motor is shown in Fig. 46 with speed-torque curves.

FIG. 43—Typical Speed-Torque Curves for Wound-Rotor Motor



Wound-rotor motors are used where high starting torque is required to bring loads to full speed smoothly and quickly, with low starting current. As shown above, speed-torque characteristics of wound-rotor motors vary with resistance in the rotor circuit. The motor can produce speed-torque characteristics similar to the various designs of squirrel-cage motors. Such a motor is, therefore, an adjustable varying speed motor. Speed can be established for a given load by adjusting the rotor resistance; but, once set, the speed will vary according to load conditions.

FIG. 44—Manual Wound-Rotor Secondary Controller with Primary Contactor


Contacts are closed only when all resistance is in rotor circuit-prevents closing main contactor without rotor resistance
*External resistance unit
Line
Wound-rotor motor
Start
Stop
Operating coil

*Resistance unit may be faceplate controller with resistors built-in or drum controller for starting duty or speed-regulating duty, with separately-mounted grid resistor assembly.

FIG. 45—Two-Step Automatic Starting of Wound-Rotor Motor

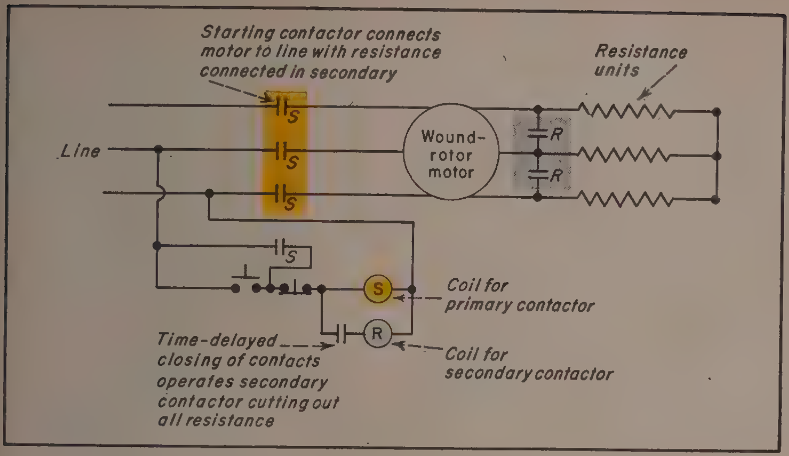
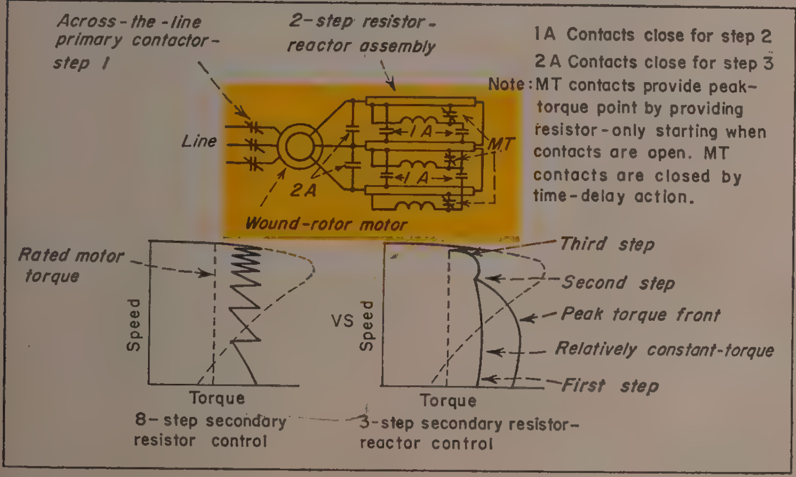

Starting contactor connects motor to line with resistance connected in secondary
Resistance units
Line
S
S
S
Wound-rotor motor
R
R
S
S
Coil for primary contactor
R
Time-delayed closing of contacts operates secondary contactor cutting out all resistance
Coil for secondary contactor

FIG. 46—Resistor-Reactor Starter for Constant-Torque Control of Wound-Rotor Motors


Across-the-line primary contactor-step 1
2-step resistor-reactor assembly
1A Contacts close for step 2
2A Contacts close for step 3
Note: MT contacts provide peak-torque point by providing resistor-only starting when contacts are open. MT contacts are closed by time-delay action.
Line
1A
1A
MT
2A
Wound-rotor motor
Rated motor torque
Speed
Torque
VS
Speed
Torque
Third step
Second step
Peak torque front
Relatively constant-torque
First step
8-step secondary resistor control
3-step secondary resistor-reactor control

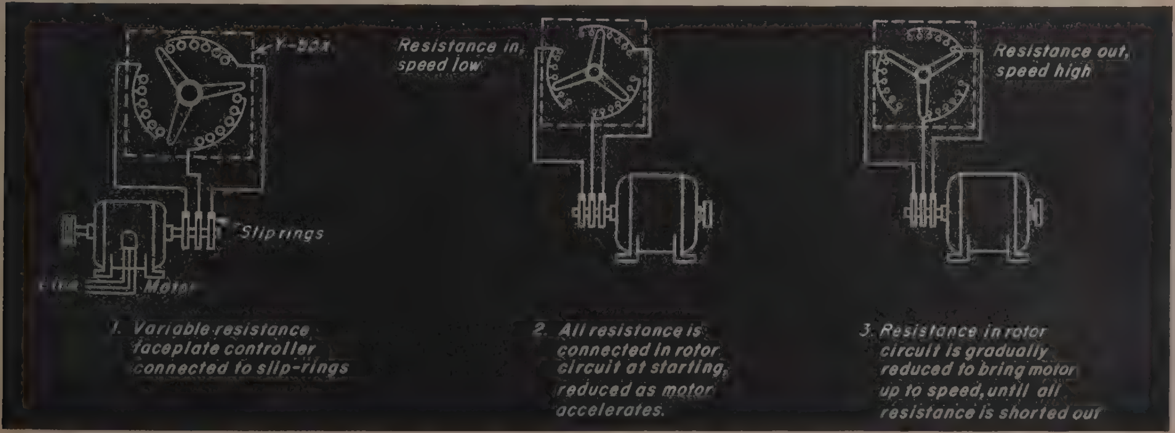
SPEED REGULATORS

Selection of a speed regulator for use with a wound-rotor motor is based on characteristics of the load and the motor. From the standpoint of load, there are two basic types: constant-torque or machine loads, and variable-torque or fan loads. Speed regulators are made for these two types of service. The size and current characteristics of the motor at various speeds and at locked rotor should also be related to the speed regulator. All of these factors determine the way in which rotor circuit resistance will be varied to obtain speed control.

For use in the secondary circuit to obtain starting, speed control and/or reversal of wound rotor motors, manual drum controllers and faceplate controllers find wide application. A typical manual faceplate controller for speed regulation and reversing consists of a number of insulated contacts mounted in a circle on the front of the starter housing. See Fig. 47. These contacts are wired to taps on resistors mounted behind the controller plate. A three-legged rotating arm is pivoted at the center of the circle of contacts and arranged with contacts of its own to wipe the stationary contacts when rotated. The rotating arm is operated by a handle, producing stepped reduction in resistance and forward motor rotation when moved one way and stepped reduction in resistance with reverse motor rotation when moved the other way.

Typical non-reversing drum switches for secondary rotor circuits are made for either starting

FIG. 47—Secondary-Circuit Speed Control of a Wound-Rotor Motor (Without Reversing)


Resistance in, speed low
Resistance out, speed high
Slip rings
Motor
1. Variable resistance faceplate controller connected to slip-rings
2. All resistance is connected in rotor circuit at starting, reduced as motor accelerates.
3. Resistance in rotor circuit is gradually reduced to bring motor up to speed, until all resistance is shorted out

duty or speed control. Such units switch taps on separate resistor units to control speed. Interlocking contacts provide coordination with magnetic starters in the primary. One type of interlock will provide for closing the primary contactor when the drum switch handle is moved to its first position. Another type of interlock is for use with a pushbutton station, to provide closing of the primary contactor only when the drum switch is in the "OFF" position. Units are made in sizes up to 500 hp, 600 volts, with resistors for the type of duty required. Drum controllers are also available with motor operation of the drum for remote control of speed over a wide range.

Reversing of wound-rotor motors for use on cranes, hoists and many machine tools can be obtained by using a full-voltage reversing-type starter in the primary to the motor, with interlock connection to the drum switch. The secondary controller can then be of the non-reversing type. Reversing drum controllers are available for use with a non-reversing across-the-line starter.

Grid resistors and rheostats for use in wound-rotor secondary circuits are available in many types and constructions, including: cast and wound grid resistor units and banks; liquid rheostats for stepless control in steel mills, wind tunnels and pumping stations; motor-operated rheostats. Grid resistors for use with drum switches are made available unwired. They are installed in ventilated housings.

HIGH-VOLTAGE CONTROLLERS

In addition to controllers for motors rated up to several thousand hp at 600 volts, there is a variety of motor control equipment for use on motor circuits rated from 2000 volts to 5000 volts. Typical motor starters for such application are made up as compact assemblies of components in unit enclosures, for use with squirrel-cage (see Fig. 48), wound-rotor, synchronous and multi-speed motors, for full-or reduced-voltage starting, for speed control and for reversing or non-reversing service.

The enclosure for a high-voltage starter generally contains all of the required elements for operation and protection of the motor. Parts of such a starter include:

1. Short-circuit protection for the motor and the equipment is provided by either power fuses or a suitable contactor with overcurrent relays. NEMA Class E-1 starters can be used on systems where short-circuit interrupting duty does not exceed 50,000 kva. NEMA Class 2 starters use current-limiting fuses for short-circuit protection and are suited to application on systems requiring interrupting capacities to 150,000 kva at 2300 volts and 250,000 kva at 4800 volts. On a system of higher short-circuit capacity, contactors of high interrupting ratings can be used in conjunction with current-limiting reactors which keep fault currents within the capabilities of the contactors.

2. Motor disconnecting means may be provided by using fuses of the disconnecting type or by a gang-operated disconnect switch in the incoming line.

3. An air-break or oil-immersed line contactor for closing the circuit.

4. Thermal relays or induction-type relays for running overload protection, with accurate calibration and ambient compensation.

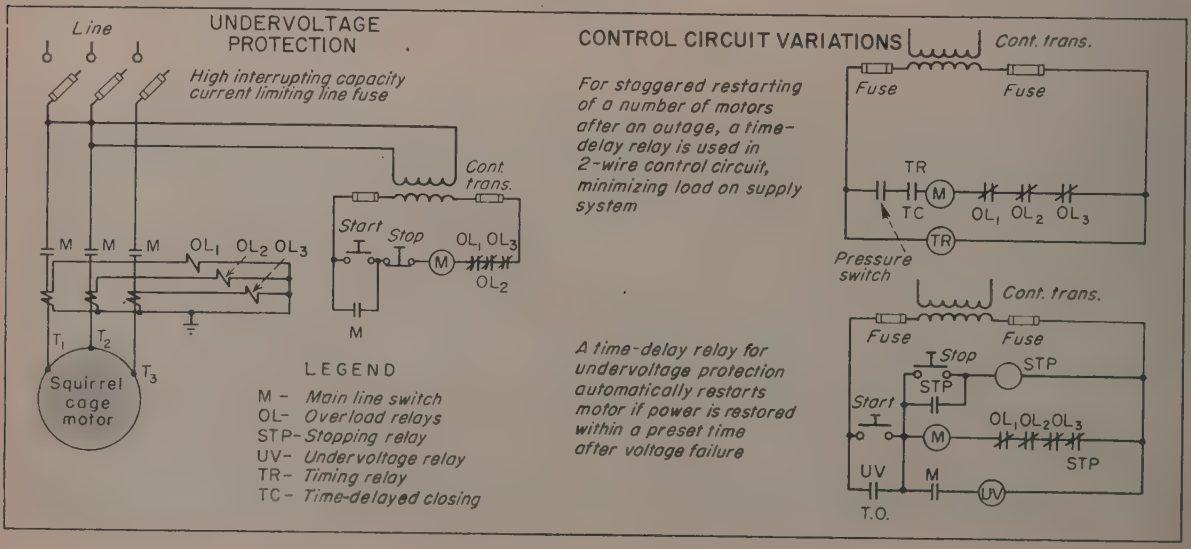
5. Transformer and fuses for low-voltage control circuit.

6. Undervoltage relay protection and protection against single-phasing.

7. Electrical and mechanical interlocks for protection of personnel may include: de-energizing the starter by opening compartment door, requiring starter to be disconnected before doors can be opened.

Because the proper selection and integration of components for a high-voltage starter for a particular application is a detailed engineering task, the various manufacturers of such equipment offer consultation and engineering service in the application of the best type of control equipment. Custom design and construction of these starters assure effective control for any set of requirements.

FIG. 48—High-Voltage Starter for Squirrel-Cage Motor



Line
UNDERVOLTAGE PROTECTION
High interrupting capacity current limiting line fuse
Cont. trans.
Start
Stop
OL1 OL3
OL2
M M M
OL1 OL2 OL3
M
T1 T2 T3
Squirrel cage motor
LEGEND
M - Main line switch
OL- Overload relays
STP- Stopping relay
UV- Undervoltage relay
TR- Timing relay
TC - Time-delayed closing
CONTROL CIRCUIT VARIATIONS
Cont. trans.
For staggered restarting of a number of motors after an outage, a time-delay relay is used in 2-wire control circuit, minimizing load on supply system
Fuse
Fuse
TR
M
TC
OL1 OL2 OL3
TR
Pressure switch
Cont. trans.
A time-delay relay for undervoltage protection automatically restarts motor if power is restored within a preset time after voltage failure
Fuse
Fuse
Stop
STP
STP
Start
M
OL1 OL2 OL3
STP
UV
M
UV
T.O.

SYNCHRONOUS MOTOR STARTERS

Synchronous motors are made in sizes from about 20 hp to 700 hp, up to 600 volts and from about 50 hp to several thousand hp in the range from 2000 volts to 5000 volts. The operating characteristics of the synchronous motor suit it to use for power-factor correction to offset the poor power factor of heavy concentrations of induction motors. They are also used for exact, constant-speed, slow-speed drives in many industrial applications and for maximum efficiency on continuous heavy loads, in excess of 75 hp.

Synchronous motors are essentially synchronous alternators operating as motors. A 3-phase line feeds current to the stator and dc is supplied to the rotor. The rotor has a field winding and a squirrel-cage winding. Reaction between magnetic fields causes the rotor to come to rotate at synchronous speed with the rotating magnetic field of the stator. As a result, the synchronous motor operates at constant speed.

Starters for synchronous motors are made for full-voltage starting and for autotransformer, reactor-type or resistor-type reduced-voltage starting, at high and low voltages. A typical low-voltage (not greater than 600 volts) synchronous starter is made in a unit package, as shown in Fig. 49, and operates as follows:

A full-voltage magnetic line contactor connects the ac motor winding to the line. The rotor winding is closed through a starting and discharge resistor. Then the motor starts, accelerates and comes up to synchronous speed as a squirrel-cage motor. At the correct rotor speed, a polarized field-frequency relay and reactor automatically apply dc excitation to the field to synchronize the motor with maximum synchronizing torque, while drawing minimum line current. This same relay will remove the field excitation if the motor should be pulled out of step and will reapply the field when the motor again synchronizes. This relay operates automatically to protect the motor under all conditions.

Synchronous motor starters are available in compact assemblies of all necessary components in unit enclosures. High-voltage starters, as illustrated in Fig. 50, can incorporate short-circuit protection for the required rating of interrupting capacity, and reduced-voltage units use autotransformers or starting reactors to limit the current, with accelerating contactors to remove the starting devices. Usual protection in synchronous starters includes: running overload, undervoltage, and out-of-step relay protection. The out-of-step relay protects the squirrel-cage winding on the rotor against damage due to overheating which results from prolonged motor operation below synchronous speed. The squirrel-cage winding is designed for starting duty only.

And because application of synchronous motors is a rather special task, extreme care should be taken in selecting the required controller.

FIG. 49—Unit Controller for Low-Voltage Synchronous Motors

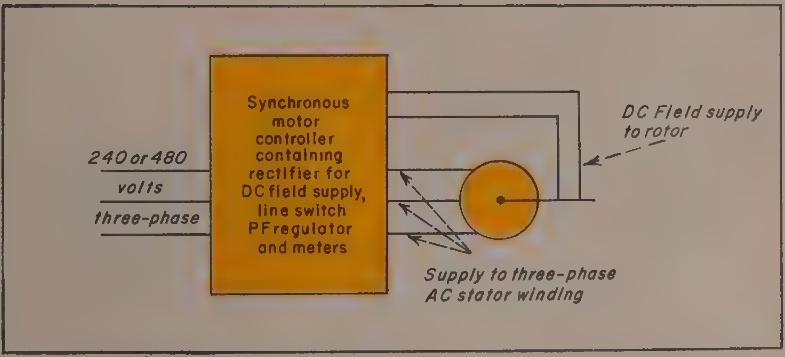
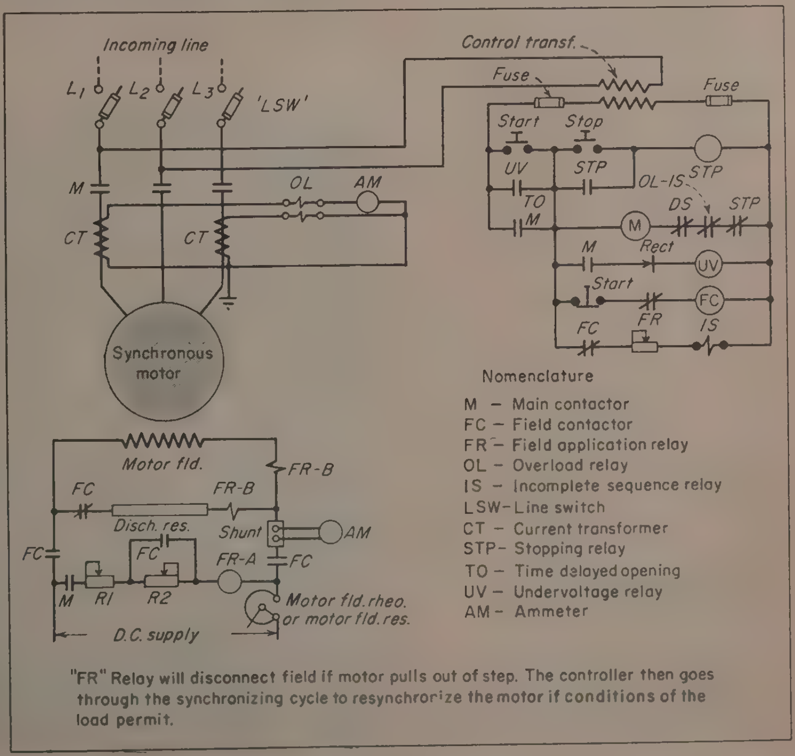

Synchronous motor controller containing rectifier for DC field supply, line switch PF regulator and meters
240 or 480
volts
three-phase
DC Field supply to rotor
Supply to three-phase AC stator winding

FIG. 50—Full-Voltage Synchronous Motor Starter for High-Voltage Supply



Nomenclature

M – Main contactor
FC – Field contactor
FR – Field application relay
OL – Overload relay
IS – Incomplete sequence relay
LSW – Line switch
CT – Current transformer
STP – Stopping relay
TO – Time delayed opening
UV – Undervoltage relay
AM – Ammeter

"FR" Relay will disconnect field if motor pulls out of step. The controller then goes through the synchronizing cycle to resynchronize the motor if conditions of the load permit.

Direct-Current Motor Controls

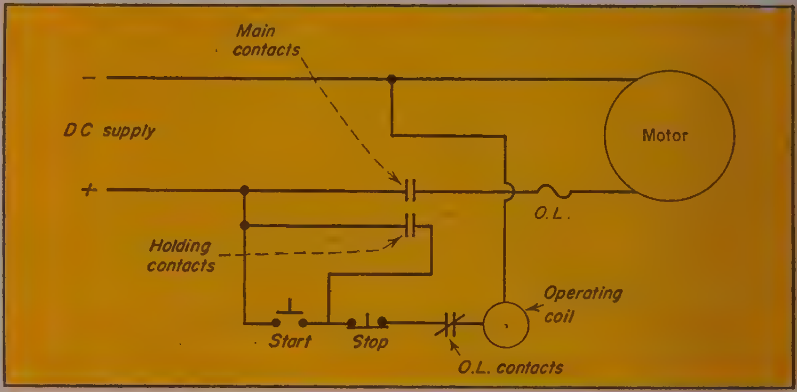
Two basic methods are used for starting dc motors: full-voltage starting and reduced-voltage starting. Full-voltage starting is confined to dc motors rated 2 hp or less. Reduced-voltage starting is used for larger motors.

ACROSS-THE-LINE

Across-the-line starting of dc motors may be done in many cases with manually-operated switches. In fractional hp ratings, double-pole switches of the toggle, key and lever type can be used for 120/240-volt dc motor control. These starting switches are the same type as used for small single-phase ac motor applications. For integral-hp dc motors up to 2 hp, across-the-line manual switches with integral pushbutton operation, the same type used for small integral-hp ac motors on single-phase or polyphase circuits, are used. Manual dc starters in fractional-hp sizes are available with or without running overload protective relays. Integral-hp manual starters have overload protection. Manual starters find application where remote control is not a requirement.

Magnetic across-the-line contactors for dc motor control up to 2 hp are used for starting, stopping and reversing dc motors where full-voltage starting will not damage the motor or its driven equipment. A single contactor is used for simple starting-stopping (Fig. 51); two interlocked contactors are used in reversing starters. Applications and hookup of these starters is generally the same as for ac magnetic starters. Two- and 3-wire control circuits can be used in the operating coil circuit with pushbuttons or other pilot devices to provide remote or automatic operation. Running overload protection is included in the starters and undervoltage protection or undervoltage release can be provided for the motor with these starters.

FIG. 51—Magnetic Full-Voltage Starter for DC Motors up to 2 HP

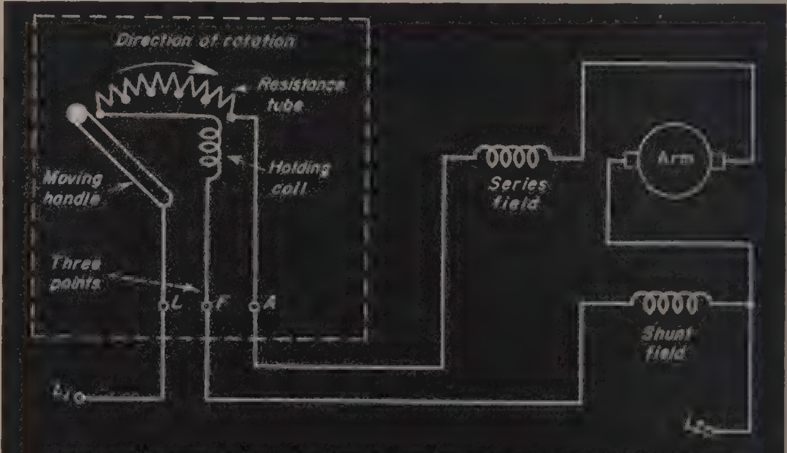


REDUCED-VOLTAGE STARTING

There are characteristics of dc motors which make reduced-voltage starting necessary for motors above 2 hp. On starting, dc motors draw very high current because their armature windings are designed to have very low resistance to minimize heat losses. If full line voltage were applied to such motors, the heavy current flow through the winding while at rest might possibly cause permanent damage to the motor. For this reason, dc motors above 2 hp are started at reduced voltage. In starting, a value of resistance is placed in series with the motor winding across the full-voltage line, to limit the starting current to a safe value. Then as the motor starts rotating, it generates a counter-emf which effectively increases the internal resistance of the motor and reduces the voltage across the motor. This generation of counter-emf permits gradual reduction of the amount of resistance connected in series to keep the current from rising too high. When the motor has come up to full speed, the external resistance can be cut out.

Both manual rheostat-type starters and automatic-type starters are

FIG. 52—Three-Point Starting Box for Compound DC Motor



The manually operated moving handle regulates the amount of resistance in the armature circuit. The holding coil, which is in the shunt-field circuit, magnetically holds the handle in its final position with all of the resistance out of the armature circuit.

This starter is commonly used with dc motors of 1- or 1½-hp capacity. For motors of lower horsepower rating, across-the-line starting is usually used.

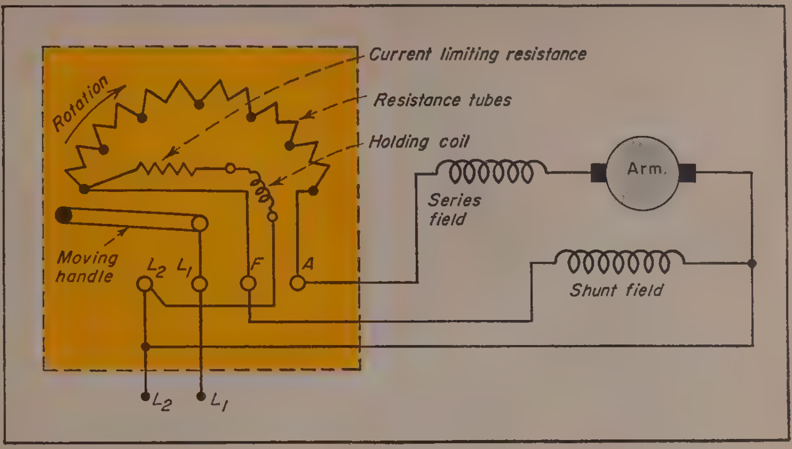
available for controlling the starting of dc motors with resistors. These starters are compact assemblies of the required parts—external resistance unit and the means for reducing and eliminating the resistance—in unit enclosures.

The 3-point starting box or faceplate starter is a manual dc starter commonly used with 1 or 1½ hp, shunt- or compound-wound dc motors. It is shown in Fig. 52. The unit consists of a plate on which a number of contacts are arranged in an arc, tapped resistances on the back of the plate, a handle with a contact on its moving end connected to one of the starter terminals and a magnetic coil. With the handle in the "OFF" position, the line to the motor is open. As the handle is moved so that its end follows the arc of contacts, it closes the circuit to the motor with all of the resistance in the circuit and energizes the field and holding coil when it touches the first contact. Continued movement of the handle reduces the amount of resistance as it touches each succeeding contact. Movement must be gradual to permit smooth acceleration. When the handle has moved to the last resistance tap contact, all of the resistance is shorted out and the motor is connected across full line voltage. In this position, the magnetic holding coil will hold the handle until the shunt field circuit is interrupted. When the field circuit is interrupted, the holding coil is de-energized and the handle is spring-returned to its original "OFF" position. This is called "no field" protection. Voltage failure or low voltage can also de-energize the coil.

The 3-point starter gets its name from the three terminals used—one marked "L" for one of the supply lines, one marked "F" for connection to the motor field, and one marked "A" for connection to the motor armature.

Another manual reduced-voltage dc starter is the 4-point starter, shown in Fig. 53, which is similar in construction and operation to the 3-point starter. It is used for shunt- and compound-wound dc motors, and it differs from the 3-point unit in the hookup of the holding coil and the shunt field. The starter gets its name from the four terminal posts on its front. One post marked "L_1" is for one of the supply lines; another post marked "L_2" is for the other supply line; another post marked "F" is for the field connection; and the last post marked "A" is for the armature connection.

FIG. 53—Four-Point Starting Box for Compound DC Motor



As the spring-loaded handle of the starter is moved to the right, it makes contact with the full-resistance tap contact, closing three current paths—one through the armature and series field in series with all of the starting resistance, one through the magnetic holding coil in series with a current-limiting resistance, and one through the shunt field connected directly across the line. Movement of the handle through the resistance-tap contacts cuts resistance out of the armature circuit and into the holding coil and shunt field circuits. In the final position, the handle is held by the magnetic coil, and all of the starting resistance is out of the armature circuit and in series with the parallel combination of the holding coil and shunt field.

As in the case of the 3-point starter, the 4-point starter provides "no-voltage" protection—failure of line voltage de-energizes the holding coil, releasing the handle which returns to the "OFF" position.

SPEED CONTROL

Speed control of dc motors can be effected in a number of ways depending upon the type of motor and the conditions of load. The speed of shunt and compound motors, for instance, can be varied by means of a rheostat in the shunt-field circuit. Speed of series motors can be varied by controlling the series field. However, considerable speed variation of all types of dc motors can be obtained by control in the armature circuit. The use of a variable resistance unit in the armature circuit can be used for manual control of speed, although the loss in the resistance unit reduces efficiency

FIG. 54—Field Rheostat for Speed Control of DC Motor

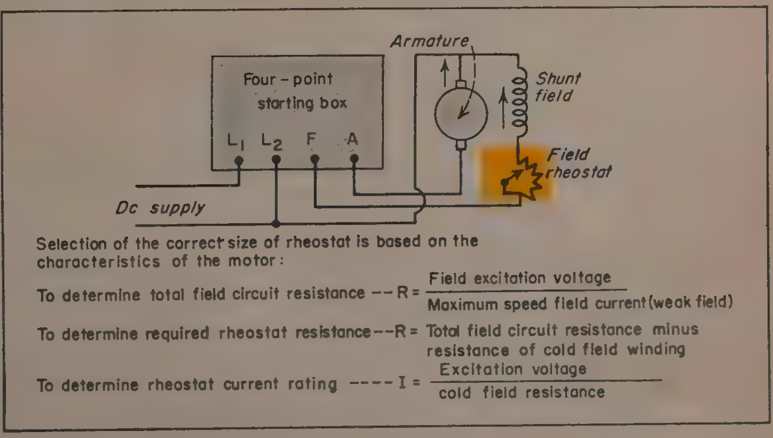
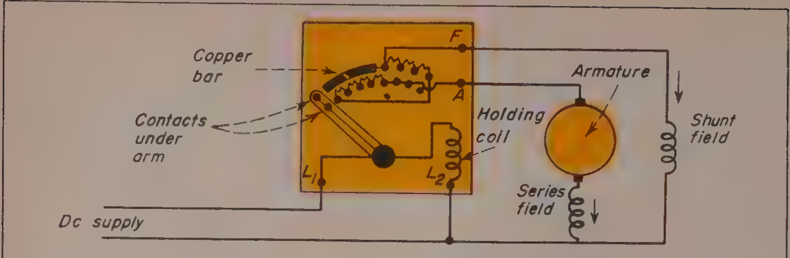

Armature
Four-point starting box
L_1 L_2 F A
Shunt field
Field rheostat
Dc supply
Selection of the correct size of rheostat is based on the characteristics of the motor:
To determine total field circuit resistance -- R = Field excitation voltage / Maximum speed field current (weak field)
To determine required rheostat resistance -- R = Total field circuit resistance minus resistance of cold field winding
To determine rheostat current rating ---- I = Excitation voltage / cold field resistance

FIG. 55—Speed-Regulating Rheostat Controlling Compound DC Motor



Operation is similar to that of four-point starter, except that the handle is pivoted with a ratchet arrangement, permitting positioning of the handle at any contact. Movement of the handle up to the fifth contact provides speed control by varying the voltage across the armature, with the bottom contact on the handle touching the contacts on the faceplate. Movement of the handle through the four upper contacts provides stepped increase in speed by adding resistance to the shunt-field circuit.

FIG. 56—DPDT Switch for Reversing Shunt-Wound DC Motor

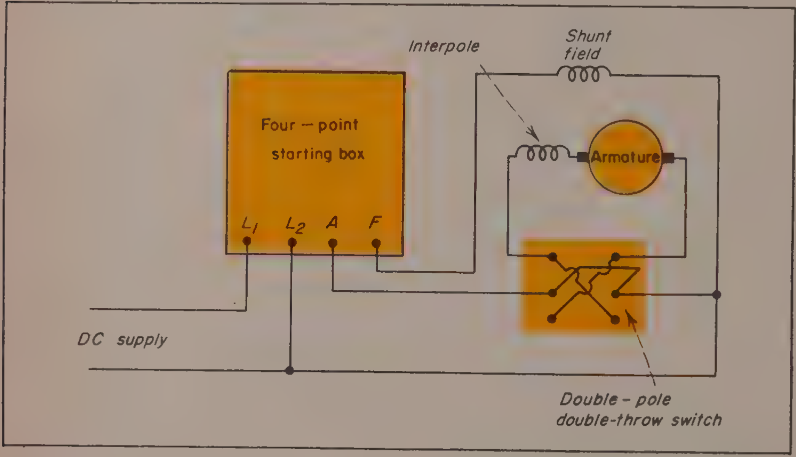
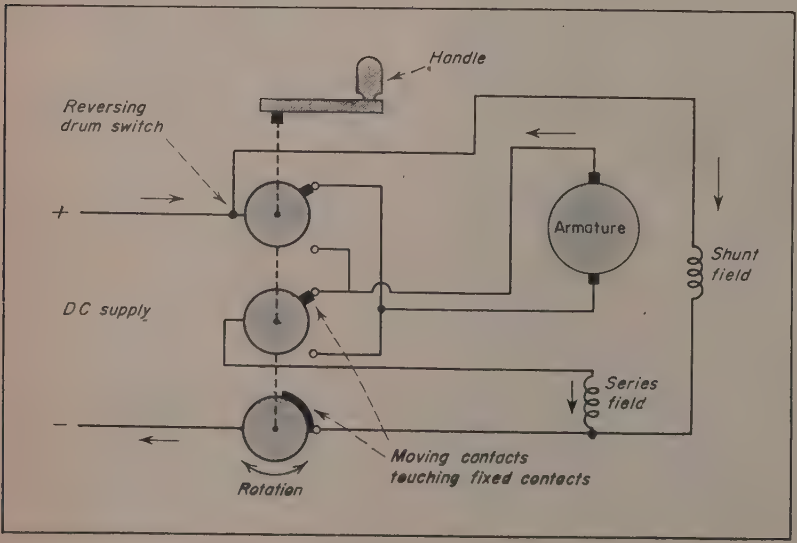


FIG. 57—Reversing Compound DC Motor with Drum Switch



and speed varies widely with load. Another type of armature control consists of varying the voltage applied to the armature. A source of variable voltage can be used to supply the armature, producing efficient and smooth control of the dc motor speed, for either reversing or non-reversing duty. And field control can be combined with armature control. A number of speed control systems using armature voltage variation are available for dc motor applications in many industrial operations.

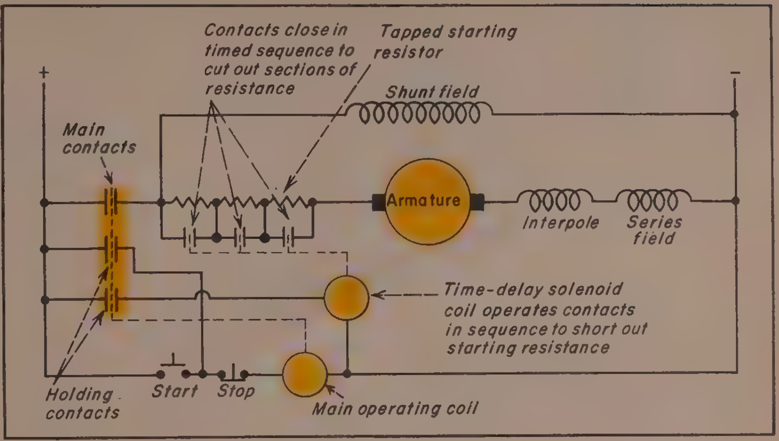
Four-point starting boxes can be readily used with available resistance units, a field rheostat, connected in the shunt field circuit to provide speed control by varying the resistance in the shunt field, as shown in Fig. 54. Speed-regulating, 4-point rheostats are integral controllers for controlling motor speed, as in Fig. 55. Combination controllers consist of a special 4-point assembly which incorporates both reduced-voltage starting and speed regulation. Rheostat type starters and controllers usually do not incorporate running overload protection for the motor. This must be provided elsewhere in the circuit, as by a magnetic contactor with overload relays on the line side of the manual controller. Manual reduced-voltage starters are used on dc motors up to about 50 hp. Such starters are sometimes combined with disconnecting means and short-circuit protection.

REVERSING

Reversing of dc motors requires reversal of current flow through either the armature or the field. The usual method for reversing consists of some type of switch assembly which will reverse the connections to the armature, such as the double-pole, double-throw switch in Fig. 56. A reversing-type drum switch, as described previously, is a common manual means for reversing dc motors, as shown in Fig. 57. When reversing is used, a motor must be braked or permitted to stop rotating before energy is applied to reverse the rotation.

Another type of controller used with dc motors is the drum controller. It may be used with shunt, series and compound motors, depending upon its particular construction and purpose. Drum controllers are used for reversing, accelerating and braking of dc motors in such applications as cranes, hoists, trolleys and wherever variation of resistance is required for control. These drum controllers are similar to the units described for wound-rotor secondary control. A handle on top controls rotation of an internal, vertical drum, making and breaking various contacts. The contact points are connected to various taps on resistance units mounted either in the back of the controller housing or separately in their own enclosure. For running overload and other protection, they are commonly used with magnetic starters, and their operation may be interlocked with the control circuit of the contactor.

FIG. 58—Magnetic DC Starter with Four-Step Acceleration for Large Motors


Contacts close in timed sequence to cut out sections of resistance
Tapped starting resistor
+
−
Shunt field
Main contacts
Armature
Interpole
Series field
Time-delay solenoid coil operates contacts in sequence to short out starting resistance
Holding contacts
Start
Stop
Main operating coil

AUTOMATIC DC CONTROLS

Automatic reduced-voltage controllers for dc motors are designed to perform all of the usual starting and accelerating operations automatically, in response to operation of a pushbutton or other pilot device. They contain accelerating contactors, resistors and all of the devices necessary for automatically changing the resistance in series with motor, in carefully timed steps of acceleration, as the motor comes up to speed. Made for use with shunt, series and compound motors, such controllers permit remote control. They have running overload relays; and because automatic starters contain magnetic contactors, they can also provide either undervoltage protection or undervoltage release. Automatic reduced-voltage controllers are available in light-duty and heavy-duty assemblies, depending upon size of motor, load conditions and frequency of operation.

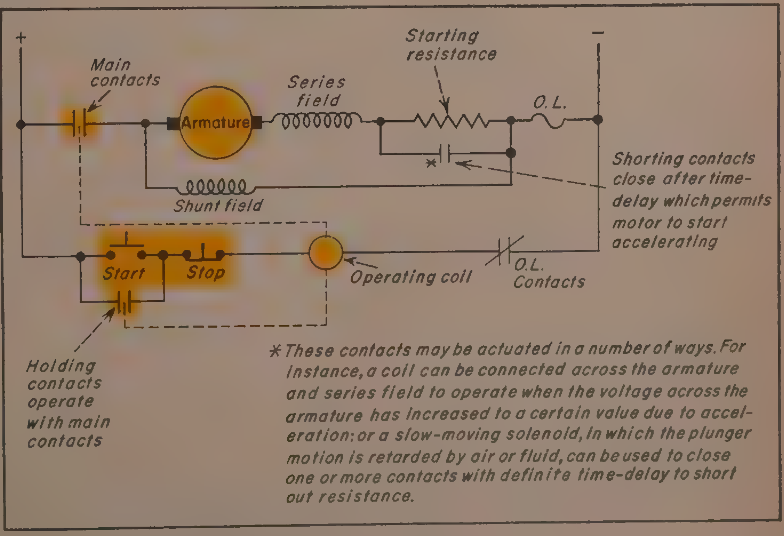
Automatic reduction in the amount of starting resistance for a dc motor varies in character according to the size of motor and the operating principle of the controller. There are a number of ways in which resistance can be removed automatically, providing automatic control of acceleration. Some common methods of stepped acceleration are shown in Figs. 58 and 59. In the case of small motors, stepped acceleration can be made with only two conditions—starting resistance in, then out. For large motors, more steps provide smoother starting.

AUTOMATIC REVERSING

Automatic-type starters are available in reversing and nonreversing models and can be obtained with provision for dynamic braking—a built-in braking resistor and a special contactor for connecting the resistor across the armature when the starter is deenergized. When the armature is disconnected from its supply circuit, its rotation causes it to act as a generator. Connecting the resistor across its terminals loads the "generator" and brakes it to a quick stop. When required, automatic starters can be equipped with relays for controlling the characteristics of the field to suit the conditions and requirements of acceleration and deceleration.

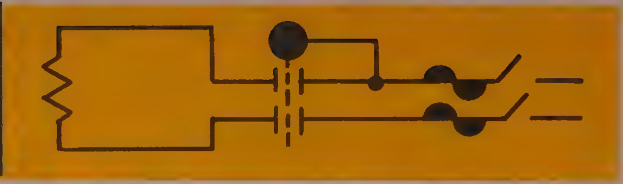
Starters for constant-speed dc motors can be obtained in completely self-contained units for ready connection into the motor circuit. Automatic starters for variable-speed motors are also available as unitized equipment for use with separate, manually operated field rheostats for speed control. Automatic control equipment is also available for automatically varying speed in response to conditions of the driven load or the operation or process involved.

FIG. 59—Magnetic Reduced-Voltage DC Starter for Shunt or Compound Motors


+
−
Main contacts
Armature
Series field
Starting resistance
O.L.
Shunt field
*
Shorting contacts close after time-delay which permits motor to start accelerating
Start
Stop
Operating coil
O.L. Contacts
Holding contacts operate with main contacts

*These contacts may be actuated in a number of ways. For instance, a coil can be connected across the armature and series field to operate when the voltage across the armature has increased to a certain value due to acceleration; or a slow-moving solenoid, in which the plunger motion is retarded by air or fluid, can be used to close one or more contacts with definite time-delay to short out resistance.

2



MAGNETIC SWITCHES

CONTROL in modern electrical systems includes many applications of magnetically actuated switching devices which, either directly or indirectly, provide ON-OFF operation of lighting and power loads. Such devices may have their load contacts connected in the circuit to the load, or they may have their contacts connected to switch the magnetic coil circuit of another device which does directly control the load. These magnetically actuated switches may control individual load devices or may switch the entire load on a branch circuit, a feeder or even service conductors.

As discussed here, these magnetically actuated switches include: magnetic contactors, remotely actuated circuit breakers used for control, control relays and automatic power transfer switches.

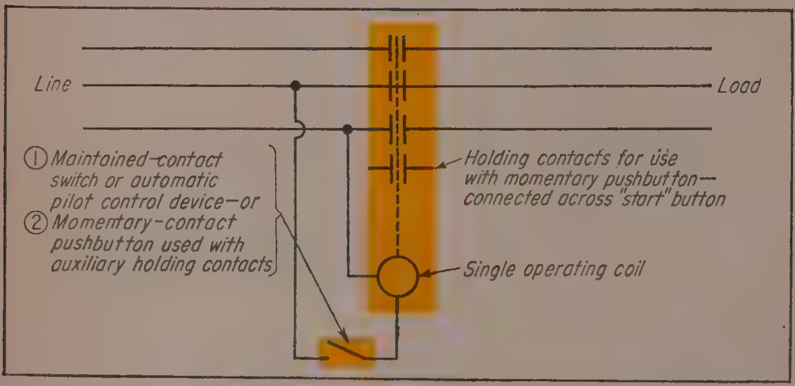
Magnetic Contactors

Magnetic contactors are contact assemblies actuated by electromagnetic action. The electromagnetic action is derived from energizing a coil which sets up magnetic attracting flux to move contacts on an armature against stationary contacts. The operation is generally identical to that of the basic magnetic motor controller already described. In fact, a magnetic motor controller without the running overload protective devices is a magnetic contactor.

The basic magnetic contactor is magnetically operated by energizing the operating coil to close the contacts and is magnetically held in position by maintaining current flow through the coil. If the voltage to the coil fails, the contactor will open. The coil must be constantly energized—constantly consuming electric energy—to keep the contactor closed. See Fig. 60.

Magnetically held contactors are available for remote and automatic switching of ac and dc load circuits where frequent opening and closing of the circuit is a requirement. Standard units are made and rated for high inrush current conditions of switching tungsten filament lamps. They are also rated for heating loads and fluorescent lighting loads, and, to the limit of their ability to break locked-rotor current, can be used to control motor loads when running overload protection is provided elsewhere. Typical contactors of this type are made in a wide range of ratings up to about 1000 amps, one to four poles, to 600 volts.

FIG. 60—Magnetically Held Contactor

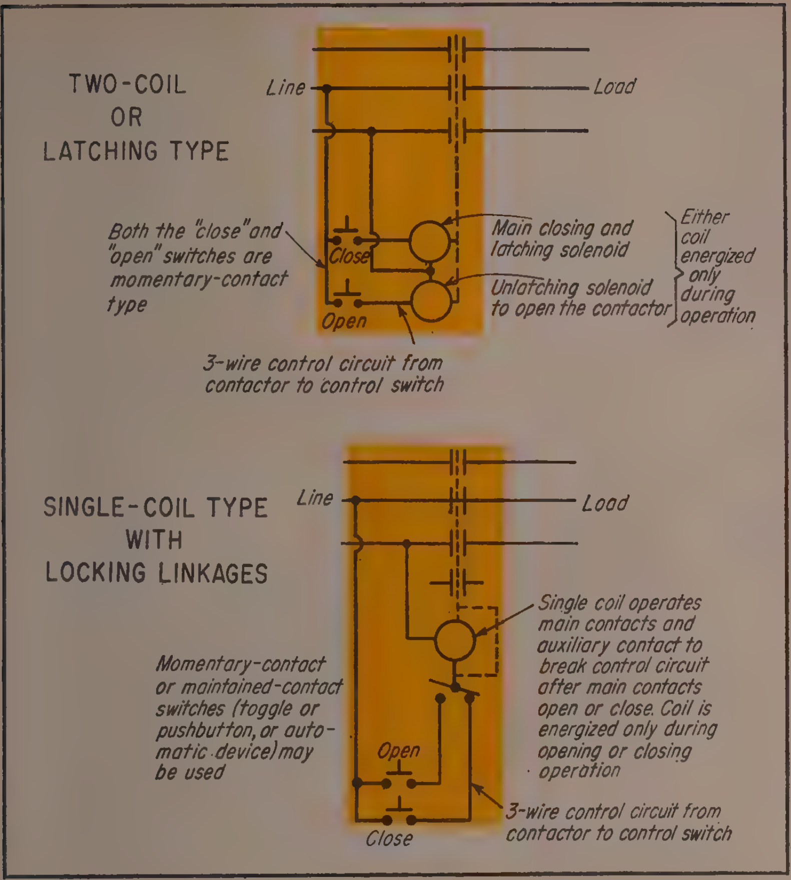

Line
Load
① Maintained-contact switch or automatic pilot control device—or
② Momentary-contact pushbutton used with auxiliary holding contacts
Holding contacts for use with momentary pushbutton—connected across "start" button
Single operating coil

To facilitate thorough control circuit design, operating coil currents for closing and holding different sizes of contactors and the wattage ratings of various coils are given for selection of proper pilot device ratings. As in the case of magnetic motor starters, the operating coil circuit may be energized at the line voltage of the switched supply or at a lower control voltage obtained through a control transformer. And either 2-wire or 3-wire control can be used to suit job needs and type of pilot devices.

Selection of magnetically held contactors for any control application depends upon the type of load to be switched—whether the load is lighting or other resistive non-inductive devices or is a motor or other inductive load. Catalog specs on contactors should be studied to determine the type of load for which the current rating is given. A contactor rated for only non-inductive loads is capable of carrying full current continuously but can interrupt only about 150% of the rated current. To control ac motors, a contactor must be capable of interrupting the stalled-rotor current of the motor which may be as high as seven or eight times the motor running current.

A variation on the basic magnetic contactor is the mechanically held contactor, in which the operating coil is momentarily energized to close the contacts and momentarily energized to open the contacts, as shown for two different types of mechanically held contactors in Fig. 61. During the time that the contacts are closed or open, the coil is not energized, and the contactor is held closed by some mechanical means or by a permanent magnet arrangement. Because of the definite switch action—with mechanically maintained open and closed positions—such a magnetic contactor is commonly distinguished from the magnetically held type by calling it a "remote switch;" i.e., a mechanical switch which can be operated in remote places by means

FIG. 61—Mechanically Held Contactors


TWO-COIL OR LATCHING TYPE
Line
Load
Both the "close" and "open" switches are momentary-contact type
Close
Open
Main closing and latching solenoid
Unlatching solenoid to open the contactor
Either coil energized only during operation
3-wire control circuit from contactor to control switch
SINGLE-COIL TYPE WITH LOCKING LINKAGES
Line
Load
Single coil operates main contacts and auxiliary contact to break control circuit after main contacts open or close. Coil is energized only during opening or closing operation
Momentary-contact or maintained-contact switches (toggle or pushbutton, or automatic device) may be used
Open
Close
3-wire control circuit from contactor to control switch

of a long control arm (the control circuit to the switch is the arm and the operating coil is the hand).

The mechanically held contactor will not change its operating position—will not trip out—on voltage dips or failures, as magnetically held contactors will do. For this reason, it offers distinct advantage on circuits to lighting and other loads where conditions of voltage fluctuation, which do not hurt the load devices, would keep dropping out magnetically held contactors. Conversely, of course, the magnetically-held contactor will provide maintained, uninterrupted closure on circuits when the voltage conditions are reasonably stable.

Mechanically held contactors can be used for handling power and lighting circuits or circuits of combination power and light loads, offering remote switching from one or more control stations. Of course, ratings must be checked for inductive and non-inductive loads. Standard contactors of this type are available for remote control of feeder connecting and disconnecting. Typical mechanically held contactors are made up to 1000 amps.

In application, magnetic contactors are usually used with momentary or maintained pushbutton stations or toggle switches. Other pilot devices or relays can also be used in contactor control circuits. In motor circuits, magnetic contactors can be used with 2-wire or 3-wire pilot devices for frequent control in combination with manual starting switches for disconnecting and overload protection.

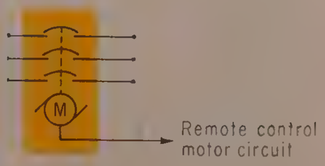
CB Switching

Circuit breakers can be adapted to remote switching applications by means of electrical operation. In the case of molded-case units, a motor operator may be attached to the front of the case to operate the handle of the CB. This operator provides ON-OFF control and affords remote resetting of the unit after tripping. In the case of large air breakers—so-called power circuit breakers—electrical operation is an available feature which provides for remote control of the device. See Fig. 62.

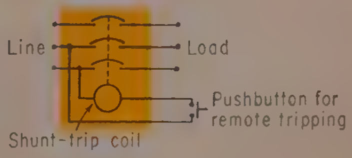
Another magnetic switching feature possible with both molded-case and power circuit breakers is shunt tripping. Any breaker arranged for shunt tripping permits remote interruption from one or more pushbuttons or other control device, where such shutdown of a branch circuit or feeder is desired.

The use of circuit breakers for magnetic switching offers effective application where remote control and short circuit protection are needed and can be combined in one device. Such a switching unit has, by its design, current interrupting ability up to the short-circuit rating of the CB and can close against short circuits.

FIG. 62—Remote Switching with CBs



MOTOR-OPERATED MECHANISM: Opens, closes and resets breaker by remote control. Can be used for automatic reclosing or preferred-emergency hook-up by addition of relay. Also for automated installations, isolated unattended pumping stations, radar systems, etc.



SHUNT TRIP: Opens breaker by remote control, permits pushbutton remote tripping. Used to disconnect power from a remote or centralized point or to interlock with other electrical circuits (ac or dc). Can be actuated by limit switch or relay for automatic feedback control.

Control Relays

Relays are magnetically operated switching devices used for a very wide range of control applications. A relay consists of an electromagnet assembly which moves an armature to open or close one or more sets of normally open and/or normally closed contacts. A coil is energized to operate the contacts. Basically, relays are low-current, light-duty magnetic contactors. See Fig 63. However, their contacts are more often used to open and close control circuits than to operate power circuits. Relays are made with magnetically or mechanically held contacts. Mechanically held relays are similar in construction and operation to mechanically held contactors. Typical relay applications include: control of contactors, control of other relays, control of solenoids and direct switching of circuits to low-current motor and lighting loads.

A number of basic control actions can be performed with relays. Relays can be used to perform control-circuit switching at power levels higher than the capacities of initiating pilot devices, as shown in Fig. 64. Or relays with many poles can be used to convert single control-initiating signals into various combinations and sequences of control operations. Relays are widely used for protective purposes to open contactor control circuits, when their coils are placed in power circuits to respond to excessive current flow. Another common relay use is in interlocking of control circuits—the coil connected in one circuit with the contacts in another circuit or other circuits.

In general, selection of relays for various ac and dc control applica-

FIG. 63—Basic Relay Makeup

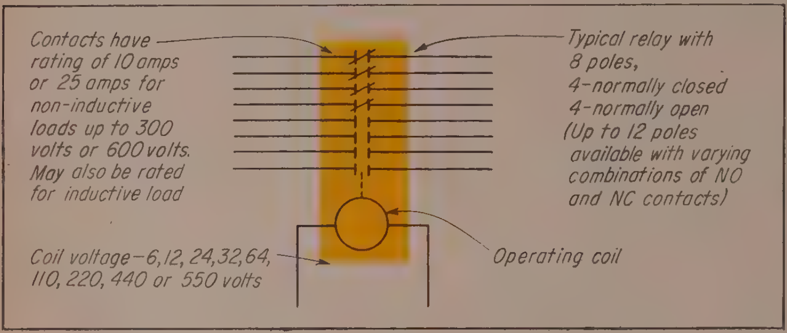
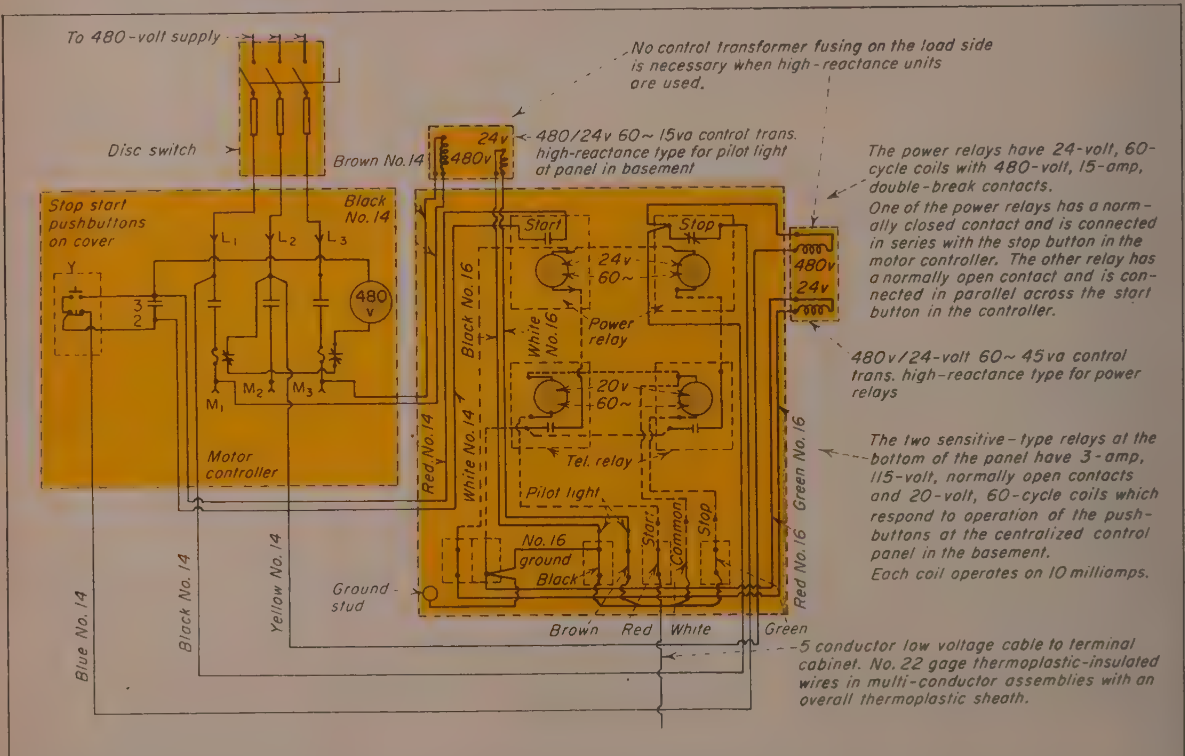

Contacts have rating of 10 amps or 25 amps for non-inductive loads up to 300 volts or 600 volts. May also be rated for inductive load
Typical relay with 8 poles, 4-normally closed 4-normally open (Up to 12 poles available with varying combinations of NO and NC contacts)
Coil voltage—6, 12, 24, 32, 64, 110, 220, 440 or 550 volts
Operating coil

FIG. 64—Two-Stage Relay Operation Provides Remote Control of Motor Starter


To 480-volt supply
Disc switch
Brown No. 14
Stop start pushbuttons on cover
Y
3
2
Black No. 14
L1
L2
L3
480 v
M1
M2
M3
Motor controller
No control transformer fusing on the load side is necessary when high-reactance units are used.
24v
480v
480/24v 60~ 15va control trans. high-reactance type for pilot light at panel in basement
Start
Stop
24v 60~
Power relay
Black No. 16
White No. 16
20v 60~
Tel. relay
Pilot light
Red No. 14
White No. 14
No. 16 ground Black
Start
Common
Stop
Ground stud
Blue No. 14
Black No. 14
Yellow No. 14
Brown
Red
White
Green
Green No. 16
Red No. 16
480v
24v
The power relays have 24-volt, 60-cycle coils with 480-volt, 15-amp, double-break contacts.
One of the power relays has a normally closed contact and is connected in series with the stop button in the motor controller. The other relay has a normally open contact and is connected in parallel across the start button in the controller.
480v/24-volt 60~ 45va control trans. high-reactance type for power relays
The two sensitive-type relays at the bottom of the panel have 3-amp, 115-volt, normally open contacts and 20-volt, 60-cycle coils which respond to operation of the push-buttons at the centralized control panel in the basement.
Each coil operates on 10 milliamps.
5 conductor low voltage cable to terminal cabinet. No. 22 gage thermoplastic-insulated wires in multi-conductor assemblies with an overall thermoplastic sheath.

Hookup shown here is one of 200 similar arrangements to remotely control fan motors in a large commercial building. Two telephone-type relays are connected to conductors from a main control panel in the basement, where the control circuits are energized from a 20-volt transformer source and actuated by a standard "START-STOP-PILOT LIGHT" station in the panel. The telephone relays operate contacts which open and close the 24-volt coil circuits of power relays. The power relays operate contacts which open and close the 480-volt coil circuit of the motor starter. Local transformers are used to supply the power relays.

tions is made on the basis of the same factors involved in selecting magnetic contactors. The electrical characteristics must be determined for the circuits in which the relay is to be used. In the circuit which the relay contacts must open and close (and this holds for each control circuit which a multi-pole relay switches), the maximum possible inrush current on contact closing must be determined. This will depend upon the size and type of load—incandescent lamp or other non-inductive load, or motor load—and on the voltage of the circuit to be switched. Then the continuous current which the relay contacts must carry will further indicate required relay specs. Finally, the maximum current which the relay will be called upon to interrupt must be determined. This current value will also vary with the type and size of load. And, as in the case of magnetic contactors, a relay used to directly control an ac motor load must be able to interrupt the locked-rotor current of the load.

Commonly used control relays are rated for continuous current per pole at 10 or 25 amps, for switching of circuits up to 600 volts. Units are made with up to 12 poles, in various combinations of normally open and normally closed contacts, with single or double throw. Catalog ratings and other catalog data relate specific relays to use with inductive and non-inductive loads under varying conditions. For direct motor operation, some relays are rated in horsepower. Operating coils for relays are available with a range of voltage ratings—6, 12, 24, 32, 64, 110, 220, 440, 550 and 600 volts.

A number of pilot devices are commonly used to control the coil circuit in a relay. For 2-wire control, typical pilot devices are automatic and include: single-pole, single-throw thermostats or humidistats; single-pole float or pressure switches; or interlocking or auxiliary contacts of some other relay or contactor. For 3-wire control, the standard START-STOP momentary-contact pushbutton station, in combination with a holding contact, is used. For mechanically held relays, momentary contact pushbuttons or toggle switches are used as shown for contactors in Fig 61.

FIG. 65—Relays for Thermostat Control

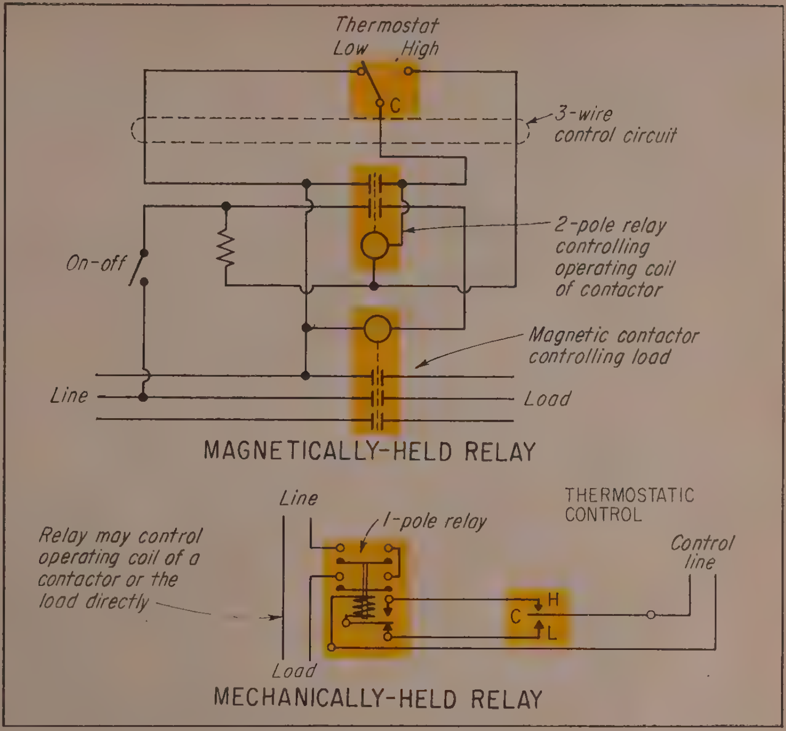
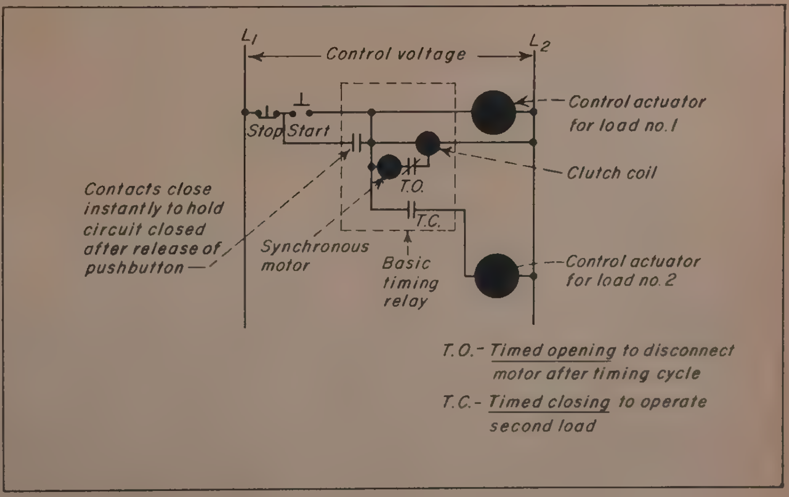

Thermostat
Low
High
C
3-wire control circuit
2-pole relay controlling operating coil of contactor
On-off
Magnetic contactor controlling load
Line
Load
MAGNETICALLY-HELD RELAY
Line
1-pole relay
THERMOSTATIC CONTROL
Relay may control operating coil of a contactor or the load directly
Control line
H
C
L
Load
MECHANICALLY-HELD RELAY

FIG. 66—Motor-Driven Timing Relay for Precise Sequencing of Operations Over Long Time Periods


L_1
Control voltage
L_2
Stop
Start
Control actuator for load no. 1
Clutch coil
T.O.
T.C.
Contacts close instantly to hold circuit closed after release of pushbutton
Synchronous motor
Basic timing relay
Control actuator for load no. 2
T.O. - Timed opening to disconnect motor after timing cycle
T.C. - Timed closing to operate second load

One version of the standard control relay is designed for use with thermostats in which the contacts can close and carry the coil current of the relay but are too delicate to interrupt the coil current. Such a relay is used with 3-wire thermostats or similar pilot devices which have a slow-moving element to make contact with a stationary contact at each limit of its back-and-forth movement. When the element, actuated by temperature, moves to make contact at, say, the low temperature limit, the relay coil is energized, closing the main relay contacts and the holding contacts and eventually operating some type of heating equipment to bring the temperature back up to requiring value. As the temperature rises, the thermostat element moves slowly to the other limit of its movement where it makes another set of contacts to instantaneously bypass the operating coil, opening the relay and stopping the heating equipment. In this hookup, the contacts of the thermostat are not required to interrupt the coil circuit. This circuit is shown in Fig. 65, along with the circuit for a mechanically held relay providing the same control.

Many other types of relays are finding even wider application in industrial, commercial and residential electrical systems. For instance, unit relays are made with built-in step-down control transformers—110- to 550-volt primary: 6- to 110-volt secondary—to provide lower voltage of coil operation for use with low-voltage pilot devices. Many types of ac and dc relays are made for specific applications—welding relays, close differential relays for protective purposes, machine-tool relays, reverse current dc relays, time-delay relays and motor-operated timing relays. A motor-operated time relay is shown in Fig. 66. A typical phase-failure relay is designed for use in a motor circuit to protect the motor by opening the control circuit in its magnetic starter, disconnecting the motor from the line, when single-phasing occurs in the supply system. A typical phase reversal relay is used to protect a motor against reverse rotation.

Automatic Transfer Switches

A form of contactor control assembly which finds wide use in modern electrical systems is the automatic power transfer switch. Such a switch is used to transfer a power load from its normal source of supply to an emergency source. Typical application would be transfer of a predetermined amount of a building's lighting load from the condition of normal supply by the utility to emergency supply from a diesel-electric generator or a battery bank. Such transfer would take place automatically upon failure of the normal supply. The emergency load would consist only of essential power devices and lighting for safety.

Automatic transfer switches are generally installed in the main switchboard room of a building. Three main circuit connections are necessary. The load to be supplied continuously—i.e., under normal conditions and if normal power fails—is connected to the "LOAD" terminals of the ATS (initials of Automatic Transfer Switch). The normal supply circuit for the load—either the service entrance conductors when the entire load of the building must be continuous or only one feeder from the main switchboard when only part of the building load is essential—is connected to the "NORMAL" terminals. And, finally, the output conductors from the emergency power source—generally a generator (diesel, gas or gasoline driven), a battery bank or a tap ahead of the main switch in the switchboard—are connected to the "EMERGENCY" terminals.

In addition to the main circuit connections, control connections are usually made from the ATS panel to the emergency generator to automatically start the generator when normal power fails.

Fig. 67 covers considerations to be made in the selection of automatic transfer switches.

Fig. 68 shows the basic operating diagrams of three types of automatic transfer switch assemblies, indicating some of the operating characteristics of each one.

As shown in the top diagram of Fig. 68, relays 1V, 2V and 3V provide full phase protection. If the normal voltage drops below 70% on any phase, the relay associated with that phase opens, de-energizing the source selector relay SE. Lockout relay LO is still open, awaiting establishment of proper voltage and frequency of the emergency source, and the load switching assembly is mechanically held in the normal position. As soon as the emergency source is ready to assume the load, LO will close, momentarily energizing the main operating coil, transferring the switch assembly to the emergency position. The condition in which operating power to accomplish transfer is derived from the source to which the load is to be transferred is called double-source design. When relays 1V, 2V and 3V detect restoration of normal power

FIG. 67—Selecting an Automatic Transfer Switch

1. In either the normal or emergency position, the switch assembly must have sufficient continuous current-carrying capacity for the demand load connected to the load terminals.

2. The switching units must be capable of safely and efficiently handling the currents encountered in closing the load on the emergency supply when the normal supply fails and in disconnecting the load from the emergency when normal power returns.

3. Switches must be rated to withstand the thermal and magnetic stresses of fault currents let through during the time it takes for short-circuit protective devices to clear faults.

4. Electrical- and mechanical-interlocking must assure against the possibility of the normal and emergency contact mechanisms being closed at the same time. And it must be assured that one or the other mechanism is closed depending upon the conditions of supply.

5. Protection against single-phasing of the normal supply or against excessive voltage drop should be provided in the control circuit of the switching assembly where load conditions require.

6. Proper time-delay characteristics should be incorporated in the control circuit to isolate the response of the assembly from transient voltage fluctuations in the normal system. Sensitivity to such fluctuations causes false operation of the transfer switch and may damage or destroy the starting circuit for the emergecy generator. Cranking batteries, for instance, can be completely discharged by repetitive current demands over a short period, caused by a transfer switch responding to system transients and starting the generator on each voltage dip.

to 90% or better of full voltage on all phases, they close to energize relay SE, throwing its contacts to the normal positioning, energizing the main operating control and transferring the load back to the normal source. Adjustable relays used with the foregoing hookup can provide for matching the switch operation to particular demands.

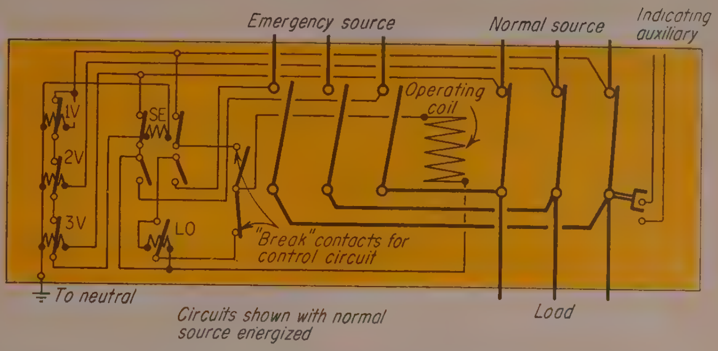
Circuit-breaker type automatic transfer switches, as shown in the bottom diagram of Fig. 68, are made in several types of construction. For applications up to 100 amps, 600 volts, a unit is made with two solenoids operating in opposition. One or the other works to produce a snap-action transfer of the load from normal to emergency or back to normal. The transfer mechanism operates on two molded-case circuit breakers, providing electrical operation with mechanical holding in either position. Electrical and mechanical interlocking provides either of two definite positions—normal closed, emergency open or normal open, emergency closed. And, as in the case of the single-coil, double-throw contactor described above, there is no neutral position of the transfer assembly.

Circuit-breaker transfer switches are made in the larger ampere sizes with motor-driven operation of the breaker handles. Again, these are electrically and mechanically interlocked assemblies, with double-source design of the transfer control circuit, and with no neutral position of the mechanism. Some such assemblies employ a single motor to provide the transfer; others use a separate motor for each of the two circuit breakers.

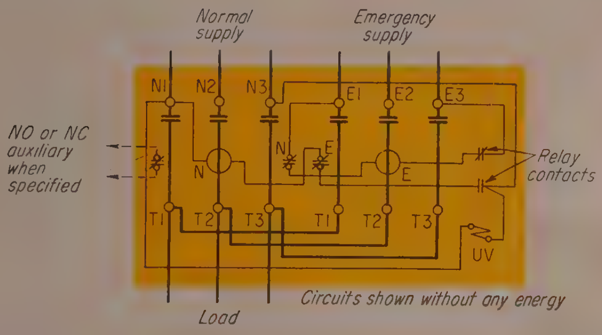
Depending upon the electrical control circuit, circuit-breaker type transfer switches may incorporate protection against voltage drop or failure on any one phase or may simply respond to failure of all phases. Full phase protection is provided by adjustable voltage relays connected line to neutral or line to line.

The breakers used in CB type transfer units may include thermal-magnetic overload trip units for units for protection of the load conductors and both sources of supply against overcurrent up to short circuits. In application of contactor-type transfer switches attention must also be paid to provision of short circuit protection for conductors and for the normal and emergency sources.

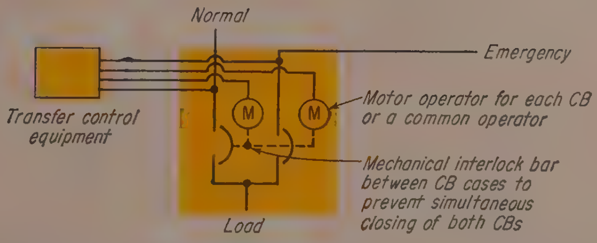
FIG. 68—Basic Types of Automatic Transfer Switches



SINGLE-COIL, DOUBLE-THROW CONTACTOR with magnetic operation for either transfer, but mechanically held in either operating position. Relays 1V, 2V and 3V provide protection against any phase failure or voltage drop on one line. Relay SE is the circuit selector, and relay LO supervises emergency.



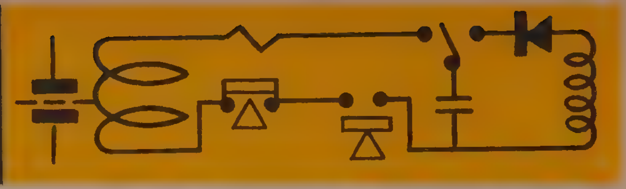
TWO SEPARATE CONTACTORS, mechanically and electrically interlocked to prevent simultaneous opening or closing. Undervoltage relay UV senses loss of normal power and initiates opening of NORMAL contactor. Availability of emergency power then closes EMERGENCY contactor. Each contactor has normally closed auxiliary contact in coil circuit of other contactor.


Normal
Emergency
Transfer control equipment
M
M
Motor operator for each CB or a common operator
Mechanical interlock bar between CB cases to prevent simultaneous closing of both CBs
Load

TWO SEPARATE CIRCUIT BREAKERS, mechanically and electrically interlocked, with a common operator or individual motor operators. Overcurrent (short circuit) protection is provided for both normal and emergency supply. Control panel may incorporate individual-phase supervisory relays and automatic starting and connection of the emergency generator or other source.

NOTE: Although different control circuit elements are indicated above for each of the three types of automatic transfer switching, any one of them may use any control circuits to accomplish desired response of the transfer assembly to conditions of the load, the normal source or the emergency supply. And a wide variety of control arrangements are possible for controlling the source of emergency power.

3



CONTROL CIRCUITS

A CONTROL circuit, as discussed here, is any circuit which has as its load device the operating coil of a magnetic motor starter, a magnetic contactor or a relay. Strictly speaking it is a circuit which exercises control over one or more other circuits. And these other circuits controlled by the control circuit may themselves be control circuits or they may be "load" circuits—carrying utilization current to a lighting, heating, power or signal device. Fig. 69 clarifies the distinction between control circuits and load circuits.

The elements of a control circuit include all of the equipment and devices concerned with the function of the circuit: conductors, raceway, relay or contactor operating coil, source of energy supply to the circuit, overcurrent protective devices and all switching devices which govern energization of the operating coil. Each element must be carefully evaluated as to its construction, rating and operating suitability to the particular application.

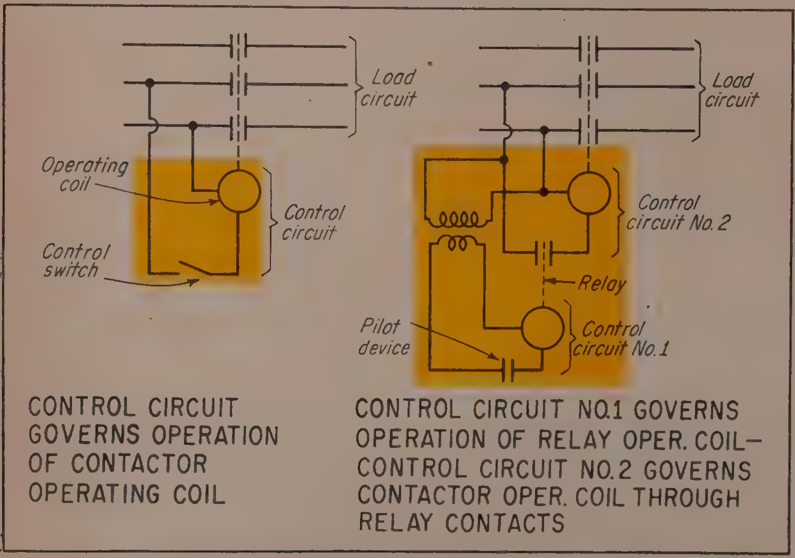
The NEC covers application of control circuits in Article 725 and in Sections 240-5 and 430-71 to 430-74. Design and installation of control circuits are basically divided into two classes (in Art. 725) according to the energy available in the circuit. Class 2 control circuits have low energy-handling capabilities; and any circuit, to qualify as a Class 2 control circuit, must have its open-circuit voltage and overcurrent protection limited to one of the sets of conditions shown in Fig. 70.

As can be seen from the requirements, the vast majority of control circuits for magnetic starters and contactors could not qualify as Class 2 circuits because of the relatively high energy required for operating coils. Note also, that any control circuit rated over 150 volts (such as 220- or 440-volt coil circuits) can never qualify as Class 2, regardless of energy. And even where a contactor coil is within the voltage and energy rating for Class 2—such as a size 00 contactor with a 110-volt operating coil, which draws 0.7 amp inrush and only 0.14 amp for holding—design must meet the specific requirement that the 110-volt supply to the coil be made from a Class 2-approved transformer rated not over 100 volt-amperes and the requirement that current-limiting means other than overcurrent protection must be provided to limit current to a maximum of one amp in the event of any fault in the circuit.

Control circuits to the operating coils of relays frequently qualify as Class 2 circuits, particularly for coils rated below 50 volts. Such circuits may take advantage of the wiring economies permitted by code installation requirements according to Sections 725-41 to 725-43.

Class 1 control circuits include all operating coil circuits for magnetic starters, contactors or relays which do not meet the foregoing requirements for Class 2 circuits. Class 1 circuits must be wired in accordance with Sections 725-11 to 725-21. Fig. 71 illustrates the major requirements. Fig. 72 covers overcurrent protection. Specific rules are given in Article 430 on the application of control circuits for the operating coils of magnetic starters. Some details are shown in Fig. 73.

FIG. 69—Control Circuit Governs Operating Coil



CONTROL CIRCUIT GOVERNS OPERATION OF CONTACTOR OPERATING COIL

CONTROL CIRCUIT NO. 1 GOVERNS OPERATION OF RELAY OPER. COIL—CONTROL CIRCUIT NO. 2 GOVERNS CONTACTOR OPER. COIL THROUGH RELAY CONTACTS

CONTROL TRANSFORMERS

In the majority of magnetic motor controllers and contactors, the voltage of the operating coil is the voltage provided between two of the conductors supplying the load, or one conductor and the neutral. Conventional starters are factory wired with coils of the same voltage rating as the phase voltage to the motor. As mentioned in the previous section of this report, however, there are many cases in which it is desirable or necessary to use control circuits and devices of lower voltage rating than the motor. Such would be the case with high-voltage (over 600 volts) controllers, for instance, in which it is necessary to provide a source of low voltage for practical operation of magnetic coils. And even in many cases of motor controllers and contactors for use under 600 volts, safety requirements dictate the use of control circuits of lower voltage than the load circuit. Although contactor coils and pilot devices are available and effectively used for motor controllers with up to 550-volt control circuits, such practice has been prohibited in applications in which atmospheric and

FIG. 70—Limitations for Class 2 Control Circuits

Class 2 systems—those in which power is limited according to maximum open-circuit voltage and maximum current rating of overcurrent protection as follows:

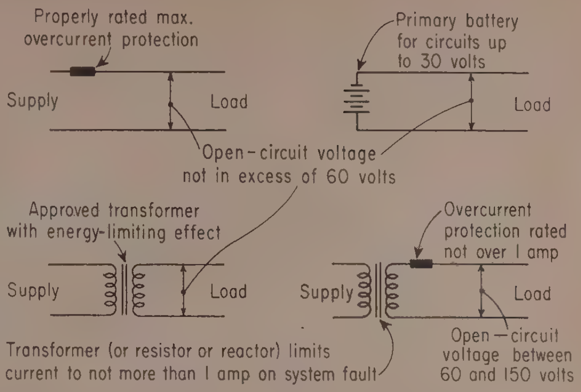
A. Max. 15 volts, 5 amps.

B. Max. 30 volts, 3.2 amps.

C. Max. 60 volts, 1.6 amps.

(In any of the three foregoing cases, overcurrent protection may be omitted where the current supply is from a transformer or other device having energy limiting characteristics and approved for the purpose, or from primary batteries.)

D. Max. 150 volts, 1 amp—provided that such circuits are equipped with current-limiting means other than overcurrent protection which will limit the current as a result of a fault to not more than one amp.


Properly rated max. overcurrent protection
Supply
Load
Primary battery for circuits up to 30 volts
Load
Open-circuit voltage not in excess of 60 volts
Approved transformer with energy-limiting effect
Supply
Load
Overcurrent protection rated not over 1 amp
Supply
Load
Transformer (or resistor or reactor) limits current to not more than 1 amp on system fault
Open-circuit voltage between 60 and 150 volts

other working conditions make it dangerous for operating personnel to use control circuits of such voltage. In such cases, control transformers are used to step the voltage down to permit the use of lower-voltage coil circuits.

Control transformers are relatively small, compact, dry-type potential transformers. They are available in many ratings to meet any common motor-control circuit application. For a very wide range of motor controllers, control transformers are available as accessory equipment to the basic starter types. They can be supplied by manufacturers as separate units with provisions for mounting external to the controller or can be incorporated in the controller enclosure, wired in with an operating coil of proper voltage rating. Such transformers can be obtained with fused or otherwise protected secondaries to meet code requirements on control-circuit overcurrent protection. And extra transformer capacity can be included to permit operation of a local lighting unit.

For low-voltage motor controllers, typical control transformers have single or double primary and secondary windings to give either a basic transformation—from, say, 480 volts to 120 volts—or a selection of transformations—as 240/480 volts primary to 120/240 volts secondary. These units range in capacity from 25 volt-amps to as high as 8000 volt-amps. Control transformers for high-voltage controllers for 2300- and 4160-volt motors are generally built into controller enclosures. In these controllers, the transformers are large, up to about 5 kva, to meet the higher requirements of large contactors.

FIG. 71—Code Rules on Wiring Coil Circuits of Starters, Contactors

1. In general, wiring of Class 1 control systems must be the same as general-purpose power and light wiring.

2. Conductors are generally limited to minimum of No. 14 but No. 18 or No. 16 may be used if installed in raceway or approved cable or flexible cord and protected at not more than 20 amps.

3. Wires larger than No. 16 must be Type R, T or other approved type. Fixed No. 18 or No. 16 must have insulation at least equal to type RF-2 or TF. Other conductors with specific approval for the purpose may be used.

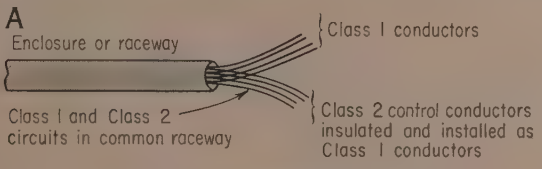
4. The number of Class 1 control circuit conductors in a raceway may be determined from Table 1, Chapter 9.

Conduit or EMT
Number of conductors per Table 1, Chapter 9—no derating for occupancy

5. Class 1 control circuit conductors do not have to be derated according to number in a raceway.

6. When Class 1 control conductors are run in raceway with power and light conductors, all conductors must be derated in accordance with note 8 of Tables 310-12 through 310-15—determining the derating factor on the basis of the number of power and light conductors only.

7. Conductors for two or more Class 1 control circuits may be run in the same raceway—ac and/or dc circuits—if all conductors are insulated for the maximum voltage of any conductor in the raceway. Other permitted installations are as follows:


A
Enclosure or raceway
Class 1 conductors
Class 1 and Class 2 circuits in common raceway
Class 2 control conductors insulated and installed as Class 1 conductors

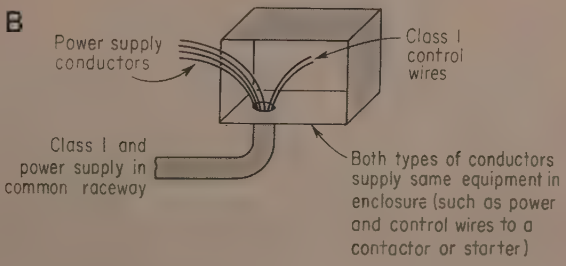

B
Power supply conductors
Class 1 control wires
Class 1 and power supply in common raceway
Both types of conductors supply same equipment in enclosure (such as power and control wires to a contactor or starter)

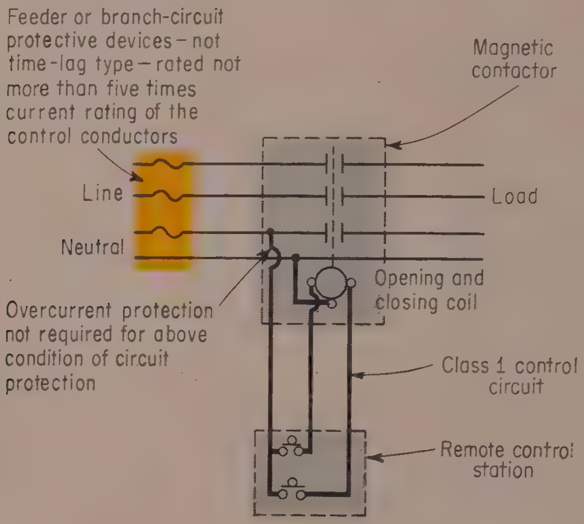
FIG. 72—Code Rules on Overcurrent Protection of Control Circuits

BASIC RULE:

Conductors must be protected against overcurrent in accordance with their current-carrying capacities from Table 310-12 through 310-15.

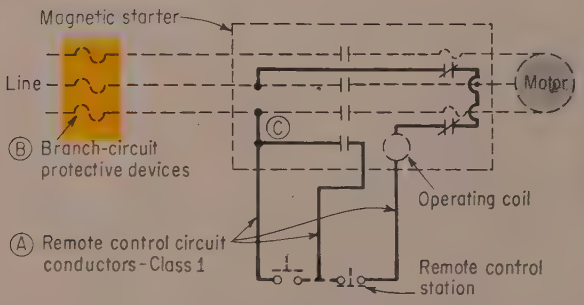
EXCEPTIONS:

In general, remote control conductors must be protected against overcurrent. Section 240-5 of the code states that such conductors can be satisfactorily protected by overcurrent devices which are not of the time-lag type and are rated at not more than 500% of the carrying capacity of the control-circuit conductors.


Feeder or branch-circuit protective devices – not time-lag type – rated not more than five times current rating of the control conductors
Magnetic contactor
Line
Load
Neutral
Opening and closing coil
Overcurrent protection not required for above condition of circuit protection
Class 1 control circuit
Remote control station

As shown above, separate protection of the control conductors is not required under the given conditions. If the stated requirements were not satisfied, a fuse or circuit breaker would have to be inserted in the control-circuit tap from the operating coil to the hot line conductor.

However, Section 430-72 modifies the above requirements for motor control circuits, as follows:


Magnetic starter
Line
Motor
Ⓒ
Ⓑ Branch-circuit protective devices
Operating coil
Ⓐ Remote control circuit conductors-Class 1
Remote control station

Control conductors above (A) may be properly protected by the branch-circuit overcurrent devices (B) if these devices are rated or set at not more than five times the current rating of the control conductors. If the branch-circuit overcurrent devices were rated or set at more than five times the rating of the control conductors, the control conductors would have to be protected by separate protective devices located "at the point where the conductor to be protected receives its supply" (C). And in the case of motor control circuits, the branch-circuit protective devices may be of the time-lag type and still qualify as protection for the control conductors.

Control transformers can be used in motor control circuits to assure maximum safety of operation by isolating the control circuit, thereby eliminating the effects of various fault conditions. A typical example is shown in Fig. 74.

Combinations of ground faults can develop to short the pilot starting device—pushbutton, limit switch, pressure switch, etc.—accidentally starting the motor even though the pilot device is in the "OFF" position. And because many remote-control circuits are long, possible faults have many points at which they might occur. Insulation breakdowns, contact shorts due to accumulation of foreign matter or moisture, and grounds to conduit are common fault conditions responsible for accidental operation of motor controllers.

Another type of motor control circuit fault can produce a current path through the coil of a closed contactor to hold it closed regardless of operation of the pilot device for opening the coil circuit. Again this can be done by a combination of ground faults which short the "STOP" device. Failure-to-open can do serious damage to motors in some applications and can be a hazard to personnel. The operating characteristics of contactor coils contribute to the possible failure of a controller to respond to the opening of the "STOP" contacts. It takes about 85% of rated coil voltage to operate the armature associated with the coil; but it takes only about 50% of the rated value to enable the coil to hold the contactor closed once it is closed. Under such conditions, even partial grounds and shorts on control contact assemblies can produce paths for sufficient current flow to cause shorting of the stop position of pilot devices. And faults can short-out running overload relays, eliminating overcurrent protection of the motor, its associated control equipment and conductors. This is evaluated in the two diagrams of Fig. 73.

Control transformers can be used to minimize the possibility of accidents due to faults by isolating control circuits for coils from power circuits to motors. With a control transformer, the coil circuit operates as an isolated circuit, independent of faults in the supply system. For use on 480-volt supply systems, a four-to-one step down transformer can be used to provide 120 volts for operation of 120-volt coils in controllers. The use of 120-volt circuits offers greater freedom from insulation breakdowns than use of higher coil-circuit voltages; and control voltages lower than 120 volts can cause trouble in the contacts of some devices. For use on 240-volt systems, coils of the same voltage can be used in circuits isolated by one-to-one control transformers. The volt-ampere rating of a control transformer must meet the requirements.

Selection of the proper control transformer for a controller is a simple matter of matching the characteristics of the control circuit to the specs of the transformer. The line voltage of the supply to the motor determines the required primary rating of the transformer. The transformer secondary must be rated to provide the desired control circuit voltage to match the voltage of the controller operating coil. The continuous secondary-current rating of the transformer must be sufficient for the magnetizing current of the operating coil and must also be able to handle the inrush current. Of course, if other devices are to be energized from the transformer, additional capacity must be provided. Complete coordination between coil circuit and transformer is provided in factory-assembled controllers.

CIRCUIT DESIGN

Careful attention should be given to design of control circuits for operating coils. It should be borne in mind that available equipment and skillful installation techniques can afford safe use of control circuits at the same voltage rating as motors up to 600 volts. And this fact should be related to consideration of the voltage drop in long remote-control circuits, in which higher coil currents at lower coil voltages may produce objectionable voltage-drop conditions.

It has been noted that control circuits may be supplied directly from the conductors of the load circuit being controlled or can be fed from a control transformer which is supplied either from the load circuit or from a separate circuit. There is also the possibility of taking control voltage from a separate system of lower voltage than the voltage of the circuit to the controlled load. Such might be the case of a control circuit from a 120-volt

FIG. 73—Disconnect for Control Circuit

Control circuits operating contactor coils, etc., within controllers present a shock hazard if they are allowed to remain energized when the disconnect is in the "off" position. Therefore the control circuit either must be designed in such a way that it is disconnected from the source of supply by the controller disconnecting means or must be equipped with a separate disconnect immediately adjacent to the controller disconnect (NEC Sec. 430-74) for opening of both disconnects.

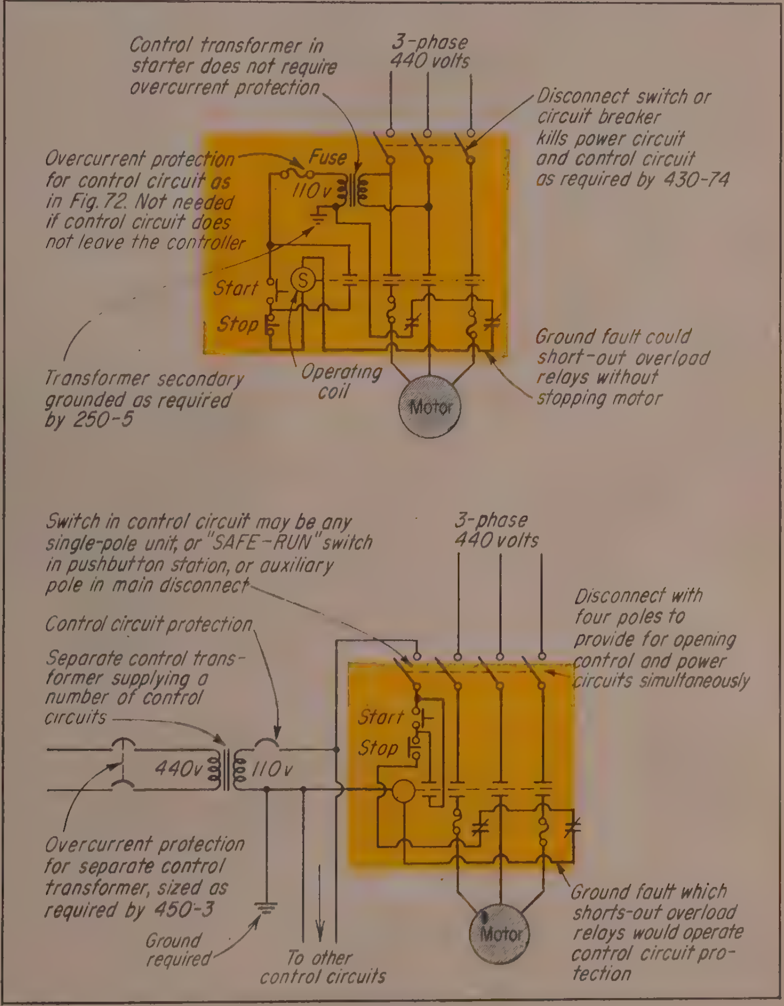

Control transformer in starter does not require overcurrent protection
3-phase 440 volts
Disconnect switch or circuit breaker kills power circuit and control circuit as required by 430-74
Overcurrent protection for control circuit as in Fig. 72. Not needed if control circuit does not leave the controller
Fuse
110v
S
Start
Stop
Transformer secondary grounded as required by 250-5
Operating coil
Motor
Ground fault could short-out overload relays without stopping motor
Switch in control circuit may be any single-pole unit, or "SAFE-RUN" switch in pushbutton station, or auxiliary pole in main disconnect
3-phase 440 volts
Disconnect with four poles to provide for opening control and power circuits simultaneously
Control circuit protection
Separate control transformer supplying a number of control circuits
440v
110v
Start
Stop
Overcurrent protection for separate control transformer, sized as required by 450-3
Ground required
To other control circuits
Motor
Ground fault which shorts-out overload relays would operate control circuit protection

FIG. 74—Control Transformer Reduces Fault Hazards

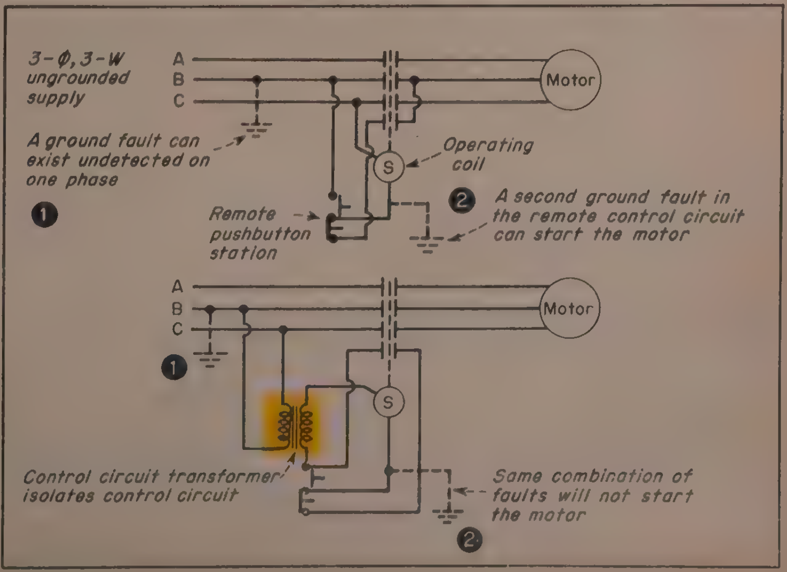
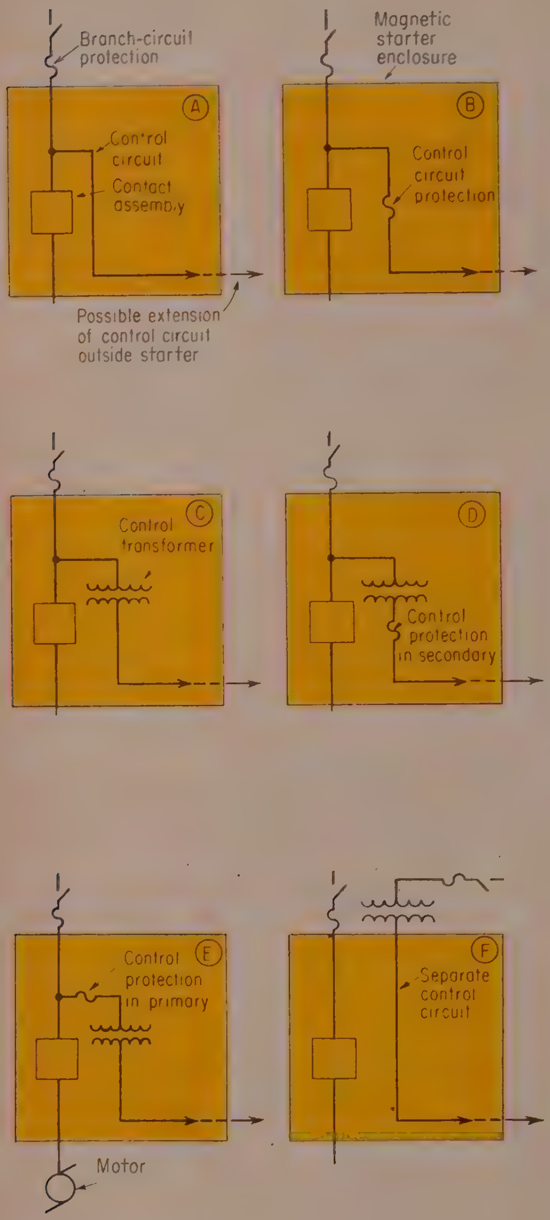

3-ϕ, 3-W ungrounded supply
A
B
C
Motor
A ground fault can exist undetected on one phase
❶
Operating coil
S
❷ A second ground fault in the remote control circuit can start the motor
Remote pushbutton station
A
B
C
Motor
❶
S
Control circuit transformer isolates control circuit
Same combination of faults will not start the motor
❷

FIG. 75—Resume of Code Rules on Control Circuit Protection


Branch-circuit protection
Magnetic starter enclosure
A
Control circuit
Contact assembly
Possible extension of control circuit outside starter
B
Control circuit protection
C
Control transformer
D
Control protection in secondary
E
Control protection in primary
Motor
F
Separate control circuit

A. Branch circuit protection is not greater than 500% of control conductor carrying capacity.

No control-circuit protective devices are required, regardless of whether control conductors leave starter or not. When control conductors do not leave starter or do not leave a machine controlled by starter, control protective devices do not have to be provided.

B. Branch circuit protection greater than 500% of control conductor carrying capacity.

If control conductors do ~~not~~ leave starter, no control circuit protection is required. If control conductors leave starter or, in the case of machine-mounted controller, the conductors are carried to a control point away from the machine, control-circuit protection is required with max. rating of 500% control conductor capacity.

C. Control transformer is furnished with unit; branch circuit protection is not greater than 500% of control conductor capacity as reflected in primary.

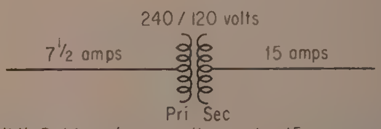
No control-circuit protective devices are required, regardless of whether control conductors leave starter or not. A transformer which is part of an apparatus (a starter) does not require individual protection.

D. Control transformer is furnished with unit; branch circuit protection is greater than 500% of control conductor capacity as reflected in primary.

If control conductors do not leave starter, no control-circuit protection is required. If control conductors leave starter, control circuit must be protected in accordance with its current-carrying capacity. Protection may be provided in secondary as shown or in primary as in (E).

E. Where control circuit protection is required as specified in (D), protective device may be placed in primary.

Rating is in accordance with carrying capacity, as reflected in primary.



With 2:1 transformer voltage ratio, 15-amp conductor—carrying capacity in secondary would be reflected in primary as 7½ amps

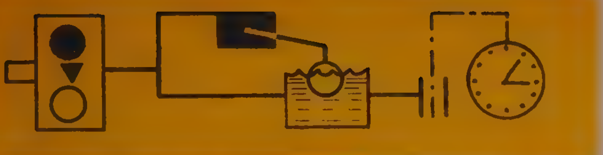
F. Separate control circuit must be protected according to conductor carrying capacity as reflected in primary, with disconnecting means. A separate control transformer must be protected at not over 250% of primary rated current.

panelboard for a contactor or starter controlling a 440-volt load circuit. Or batteries or a rectifier supply might be used to provide direct-current control circuits.

Fig. 75 is a resume of protection for control circuits of starters.

In the case of magnetic starters which are not mounted on machines, the code requires that overcurrent protection must be provided for the control circuit if the circuit is run from the starter enclosure to an externally mounted pushbutton or other control station. When the control circuit does not leave the starter enclosure (as when START-STOP buttons are in cover) overcurrent protection for the control circuit is not necessary. The control circuit of a starter on a machine does not need specific protection if the control circuit does not leave the machine.

4



MECHANICAL SWITCHES

MECHANICALLY operated switches used in modern control systems can be divided into two categories based on application:

1. Pilot devices—used to govern energy flow in control circuits, such as coil circuits of magnetic motor starters, contactors and relays.
2. Load-control switches—used to govern the flow of load current to motors, lighting units, heating equipment and other utilization devices.

Of the control switches described here, some may be used for either pilot devices or for direct load control; others are solely pilot devices.

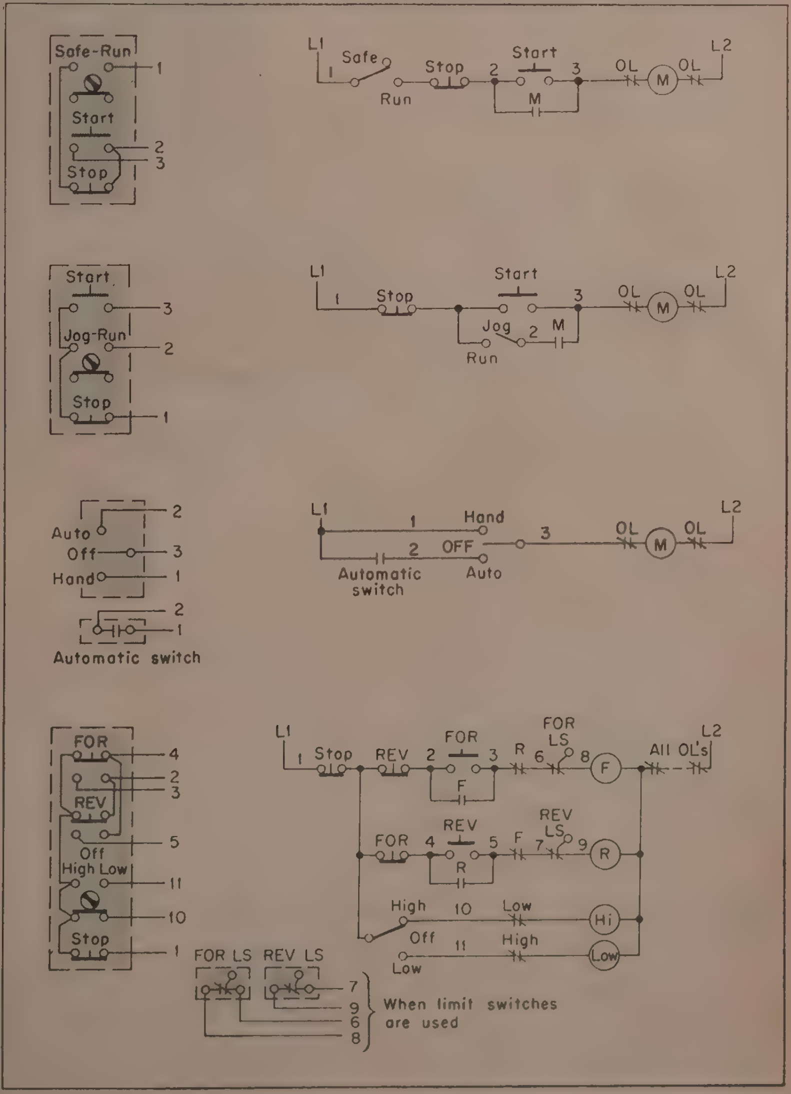
A pilot device makes or breaks contacts in the operating-coil circuit of a magnetically operated controller, under normal operating conditions. Overload relays have contacts operating in coil circuits, but not under normal conditions. Pilot devices are control circuit switches, which direct control operations in power circuits. Typical pilot devices include: pushbutton stations, selector switches, control and master types of switches, pressure switches, float switches, limit switches, time switches, thermostats and plugging switches. Of these, pushbuttons, selector switches and control and master switches must be actuated manually by an operator in attendance. The other pilot devices are designed to perform control-circuit switching automatically in response to particular conditions related to the load which the motor drives.

PUSHBUTTON STATIONS

Pushbutton stations are the most widely used pilot devices. These are compact pushbutton assemblies mounted in their own enclosures. The enclosure may also contain selector switches and/or pilot lights. The pushbuttons themselves are small manually operated switch units of either the momentary-contact type or the maintained-contact type. Pushbuttons are commonly mounted in the cover of the magnetic controller. Pushbutton stations—separate enclosed assemblies of unit pushbuttons and unit selector switches and/or pilot lights—are widely used to provide remote control of motor starters and magnetic contactors.

Unit-type selector switches used in pushbutton stations provide ready change in the operating characteristics of the control circuit. A common type of selector switch used in pushbutton stations provides three positions of the selector switch — "HAND," "OFF" and "AUTO." In the "AUTO" position, the operating-coil circuit to the associated controller is controlled automatically by whatever automatic, 2-wire pilot device is connected in the circuit—float switch or thermostat or etc. In the "OFF" position, the control circuit is open and cannot respond to the automatic device. The "HAND" position bypasses the automatic pilot device and provides direct or pushbutton-

FIG. 76—Pushbuttons and Selector Switches in Circuit Hookup



initiated manual operation of the control circuit. Another form of selector switch provides a position for "JOG" (in which the control hookup is arranged to permit jogging through a 2-wire connection of the "START" button) and a position for "RUN," in which the control circuit is rearranged to normal 3-wire operation with a holding contact. Hookups of selector switches and pushbuttons are shown in Fig. 76.

Pilot lights are used with pushbutton stations to provide visual indication of control-circuit and power-circuit conditions. The use of red, amber and green lights can be adapted to any control hookup to provide warning or indication as might be required or desirable for a particular operation. Pilot lights of the filament and neon types are available for use directly on the full-circuit voltage, up to 240 volts. For all circuit voltages, 6-volt pilot lights can be used with transformers which step the circuit voltage down to 6 volts.

Pushbutton stations and their components are divided into three construction classes to meet different conditions of application—standard duty, heavy duty and oil-tight heavy duty. Standard-duty pushbutton stations are used for light- and medium-duty applications of magnetic starters and contactors with coil ratings which will not exceed current ratings of the pushbuttons—inrush current rating and the interrupting current rating for the given coil voltage. These pushbuttons are generally limited to use with the small and medium size controllers. Heavy-duty pushbutton stations have bigger contacts and are used for light-, medium- and heavy-duty applications. They are constructed for severe duty requiring frequent application and have about twice the current ratings for inrush and interrupting capacity that the standard units have. Typical ratings for pushbuttons are as follows: standard line—30 amps inrush and 3 amps interrupting at 120 volts; heavy-duty line—60 amps inrush and 6 amps interrupting at 120 volts. Oil-tight heavy-duty pushbutton stations are specially constructed to prevent the entry of oil or other coolants or non-corrosive liquids into the assembly. These are used wherever the atmosphere is dusty or oily or where liquids might get into other stations.

The different classes of pushbutton stations are available in a range of combinations of pushbuttons, selector switches and lights.

Pushbutton stations are used in a variety of mountings and applications. Stations are available with general-purpose, dust-tight, water-tight and explosion-proof enclosures. Standard-line stations are usually surface-mounting; heavy-duty and oil-tight stations are either enclosed for surface-mounting or mounted on an escutcheon plate for recess-mounting in a large control panel or switchboard. A special variation on the usual pushbutton station is the foot-operated pushbutton which enables an operator to control a machine motor with his foot, keeping his hands free for handling the work. Another common type of pushbutton assembly is the pendant type station which has been designed as a portable station to provide control to an operator as he moves about. This is an enclosed pushbutton station which may be suspended on a trolley above a machine to permit ready movement of the station, or it may be suspended from a power cord to control an overhead trolley-mounted hoist motor.

MASTER AND CONTROL SWITCHES

A master switch is a manually operated, rotary type of pilot switch with sets of contacts and a lever type handle, used to perform control-circuit switching. A master switch performs a number of control-circuit switching operations by movement of a single handle. Common master switches are drum or cam type switches, with a number of contacts in the switch assembly.

Control switches are multi-contact master switches for mounting on switchboards or control panels or for surface mounting. These are rotary type switches with either pistol-grip handles or rotating-knob handles, used for initiating a number of control operations of contactors, relays and other control devices from the switchboard location. Control switches are normally held in the neutral (or "OFF") position by springs and can be turned either to the right or to the left to make different switching operations as required by the associated control circuits. And contact arrangements may be either momentary or maintained.

PRESSURE SWITCHES

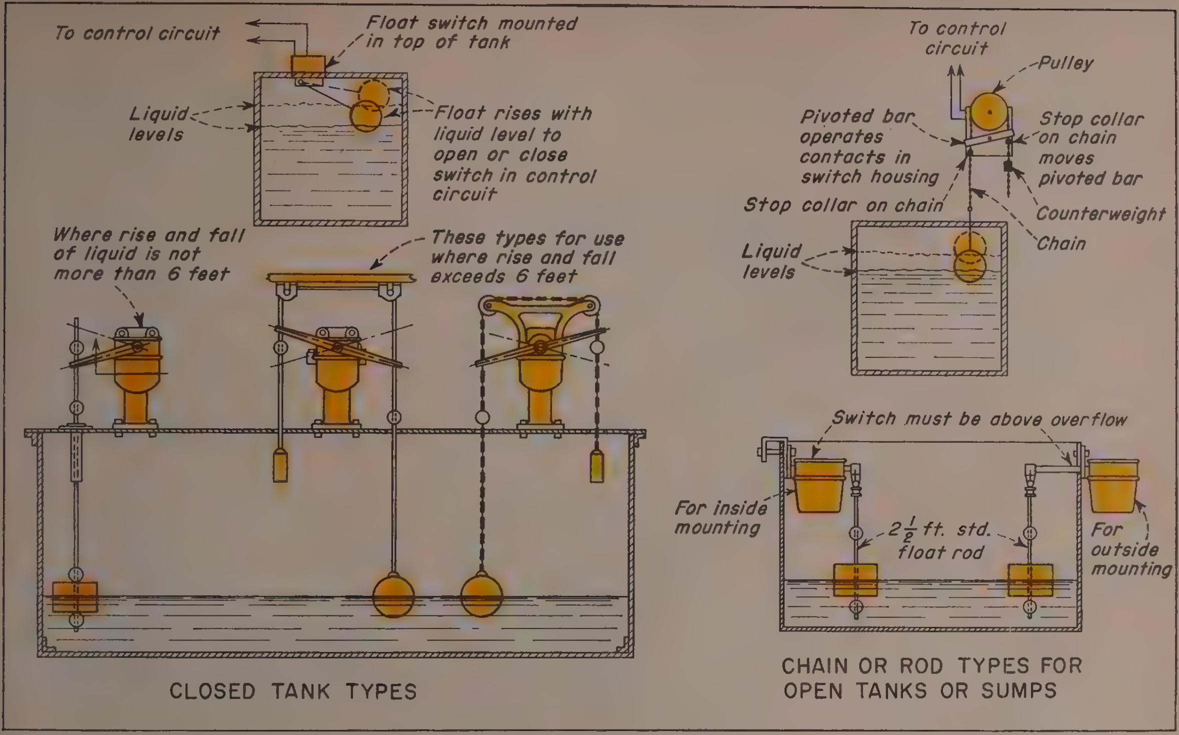
A commonly used device to automatically control operation of motors associated with water or gas systems is the pressure switch. Such a switch is an assembly containing electrical contacts arranged to be opened or closed by action of a diaphragm or piston which is actuated by pressure of water, steam, air, gas, etc. Of course, the switch must be connected to a pipe or boiler or other vessel containing the medium which operates the switch, to permit the medium to act on the diaphragm. In any application, the switch is set to operate automatically at predetermined values of pressure or vacuum, making or breaking an electrical control circuit.

A range of pressure switches is made for automatically starting and stopping motors in water-pump service and air-compressor service, with or without hand disconnect levers for shutting off the circuit manually. Such switches are rated in hp for single and polyphase ac and dc—in the range from ¼ hp at 32 volts dc to 5 hp at 550 volts, 3-phase ac. Standard units are 2-pole devices and are used for directly controlling 3-phase motors by switching two phases in 3-phase circuits. Ratings are also given for use in pilot control duty in control circuits of large magnetic starters or where remote control is required. Standard operation provides contact closing at low pressure and opening at high pressure. Reverse operation for gasoline engine cutout duty provides contact opening at low pressure and closing at high pressure. Units are available for pressure ratings from a low of about 1 psi to a high of 7000 psi. Switches are available in a number of enclosure types for different applications.

FLOAT SWITCHES

A float switch is a unit containing contacts actuated by a lever arm which is moved by a chain or rod attached to a float riding up or down with the level of liquid in a tank. Such switches are used with motors operating pumps which control the level of liquid in tanks. Common applications for float switches include automatic control of motors operating sump pumps and tank pumps.

FIG. 77—Float Switches for Automatic Control of Pump Motors


To control circuit
Float switch mounted in top of tank
Liquid levels
Float rises with liquid level to open or close switch in control circuit
Where rise and fall of liquid is not more than 6 feet
These types for use where rise and fall exceeds 6 feet
CLOSED TANK TYPES
To control circuit
Pulley
Pivoted bar operates contacts in switch housing
Stop collar on chain moves pivoted bar
Stop collar on chain
Counterweight
Chain
Liquid levels
Switch must be above overflow
For inside mounting
2½ ft. std. float rod
For outside mounting
CHAIN OR ROD TYPES FOR OPEN TANKS OR SUMPS

Float switches are rated in hp for ac and dc voltages in the same way that pressure switches are rated. Units are available with two, three and four poles, and multi-contact types are made for control of many circuits. In applications of small motors, float switches are available for direct automatic switching of the motor supply circuit. In larger sizes, or for remote control, float switches are used for pilot switching of magnetic-starter coil circuits. Typical units for tank service close the circuit at low liquid level and open the circuit at high level. For sump operation, a float switch closes the circuit at high liquid level and opens it at low level.

A number of different constructions and mounting types are available in float switches, as in Fig. 77. Multi-contact type float switches provide starting and stopping of a number of pumps in a predetermined sequence to obtain the required pumping capacity to maintain liquid level under varying conditions of level rise or fall.

LIMIT SWITCHES

A limit switch is another type of widely used pilot switch, in which contacts are made or broken in the coil circuit of a starter by travel or movement of the driven machinery. Limit switches are mounted in such a way that travel of the machine or the load it carries will, at predetermined positions, trip the contacts within the switch housing. See Fig. 78. Limit switches are made in a very wide range of constructions for different applications. The actuating lever of lever-type limit switches may be a roller type, a push type, a fork type or a plunger type. For rotating-travel equipment, rotating type limit switches are used with the internal switch assembly operated by a rotating cam or cams on a shaft.

Typical applications of limit switches include: slowing down and stopping a motor at a desired point or limit of travel for the machine or load, initiating various control actions or sequences at defi-

FIG. 78—Basic Operation of a Limit Switch

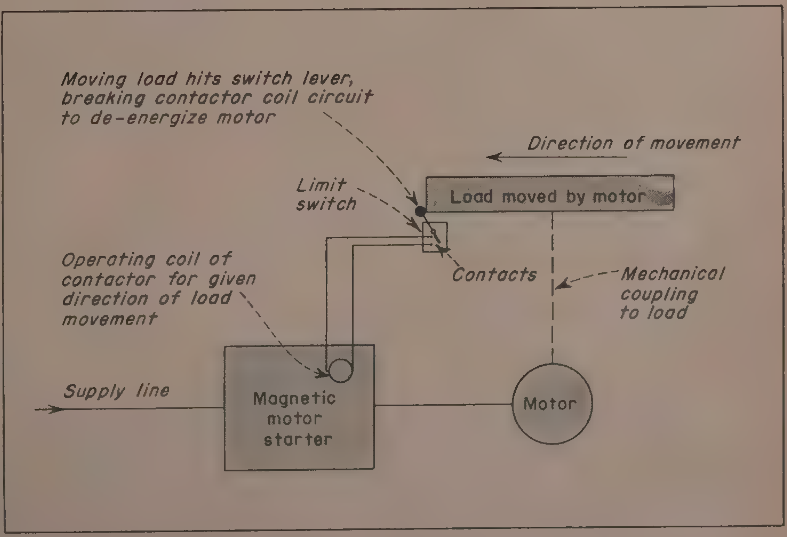
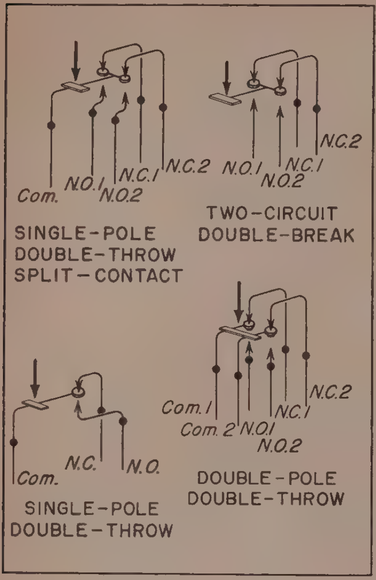

Moving load hits switch lever, breaking contactor coil circuit to de-energize motor
Direction of movement
Limit switch
Load moved by motor
Contacts
Mechanical coupling to load
Operating coil of contactor for given direction of load movement
Supply line
Magnetic motor starter
Motor

FIG. 79—Common Contact Conditions for Limit Switches



nite points in the travel of a machine or load, and interlock to provide starting or stopping of a motor or motors in response to the travel of a load driven by another motor. The simple lever-actuated limit switch is commonly called the "track-type" limit switch. It may be mounted stationary and tripped by movement of the machine or load. Or it may be mounted on the machine or load and tripped by coming into contact with some stationary object.

Limit switches are made in standard and heavy-duty units, in a number of NEMA type enclosures. Units are made with single or multiple poles, with normally open and/or normally closed contacts, with maintained contact action or spring-return action in which the contacts remain closed only while the tripping force is on the lever. Contact assemblies are shown in Fig. 79. For use on machines where oil or other coolant liquids might fall on limit switches or otherwise have an opportunity to get into the mechanism, oil-tight limit switches should be used. All limit switches are rated in terms of current for given voltage ratings, both ac and dc. And their pilot duty rating must match the coil requirements.

TIME SWITCHES

A time switch is a pilot control or direct control device in which a clock-type timing mechanism is used to open and close contacts at pre-determined times. The timing mechanism in such a switch is an electrically driven clock—or may combine electric-motor drive with spring drive. Time switches are simple ON-OFF devices and are used to open and close control circuit at given times of the day.

Typical time switches are rated up to 35 amps per pole, with one or two poles, single throw or double throw, for 24, 120 or 240 volts. Ratings are also given for watts per pole in time switches. Models are made with dials calibrated to provide scheduled switching over each 24-hour period or for 7-day calendar settings, with a given number of switch operations for the period and dials divided into hours of the day and night, and into days on calendar dial switches. Astronomical dials provide control switching according to sun time for different seasons; other dials provide for skipping switch operations for one or more days in a weekly schedule.

Time switches offer control of window lighting, home heating, refrigeration, ventilating systems, process timing, pumps and blowers, outdoor lighting, air conditioning and industrial heating. A typical application is shown in Fig. 80.

Time switches are available for switching lighting and electric heating circuits directly and for directly switching motor circuits up to about 1$\frac{1}{2}$ hp, either single phase or 3 phase. And they offer very wide use as pilot control devices in contactor and starter circuits. A SPDT time switch must be used when controlling operation of a mechanically held contactor. A SPST time switch should be used for pilot control of magnetically held contactors such as motor starters. Commonly used time switches are available with "carryover"—operation of the timing mechanism and switches by spring-clock action for up to ten hours after the power supply to the electric clock motor has failed, eliminating the need to reset the switch dial if the power supply is restored before the end of the carryover period.

PLUGGING SWITCHES

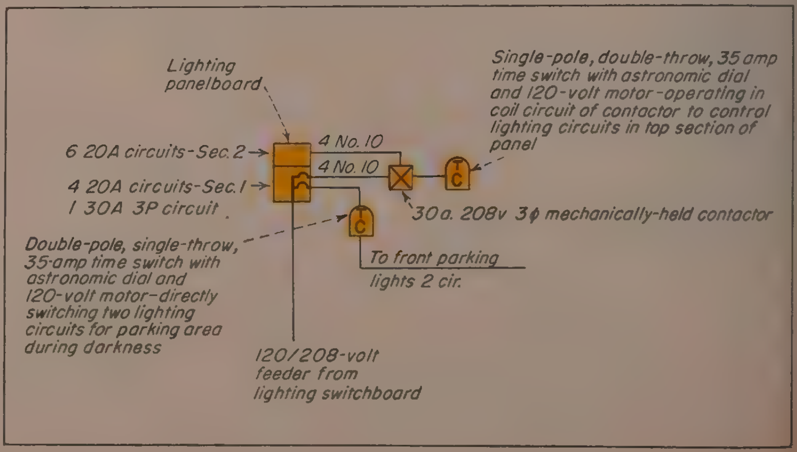
As described in the section on motor controllers, plugging is a braking method used to quickly bring a rotating motor to a stop. This is shown in Fig. 25.

A plugging switch is a centrifugal switch consisting of a housing with a protruding shaft. This shaft is connected to certain elements within the housing, and the external part of the shaft couples to the shaft of the motor which is to be plugged. Inside the housing, when the elements are rotated due to rotation of the motor shaft, a centrifugal force is produced which closes a set of contacts for the particular direction of rotation.

The zero-speed plugging use of plugging switches is widely used on reversing and non-reversing machine-tool drives, to speed up production operations.

Other uses include various types of motion interlocking—as on conveyor systems where a plugging switch on each conveyor section can be connected to the motor controller for the preceding section to assure shutdown of the feeding conveyor section if any section stops accidentally, thereby preventing pile-ups.

FIG. 80—Time Switches for Control of Lighting Provide Automatic Operation at Definite Times


Lighting panelboard
Single-pole, double-throw, 35 amp time switch with astronomic dial and 120-volt motor-operating in coil circuit of contactor to control lighting circuits in top section of panel
6 20A circuits-Sec. 2
4 No. 10
4 No. 10
4 20A circuits-Sec. 1
1 30A 3P circuit
T C
T C
30 a. 208v 3ϕ mechanically-held contactor
Double-pole, single-throw, 35-amp time switch with astronomic dial and 120-volt motor-directly switching two lighting circuits for parking area during darkness
To front parking lights 2 cir.
120/208-volt feeder from lighting switchboard

Something NEW...
designed for your convenience

Adjustable From 1 to 15 Seconds

This new Allen-Bradley development should solve such occasional problems where, upon the operation of the push button or limit switch, a slight time delay should occur. Time delay is adjustable up to 15 seconds—and it can also be introduced when "stopping" the operation—but not in both the "starting" and "stopping" cycle.

Both push button and limit switch are relatively low in cost—ideal for applications where a delay of only a few seconds is desired, and where the repetitive accuracy of the Allen-Bradley Bulletin 849 time delay relay is not necessary. Both units have single pole, double break contacts—either normally open or normally closed. They are no more difficult to install than the corresponding units without the time delay feature.

Machine tool and production system designers should have full information in their files on these new Allen-Bradley time delay push buttons and limit switches. It is yours for the asking. Write today.

ALLEN-BRADLEY

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Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

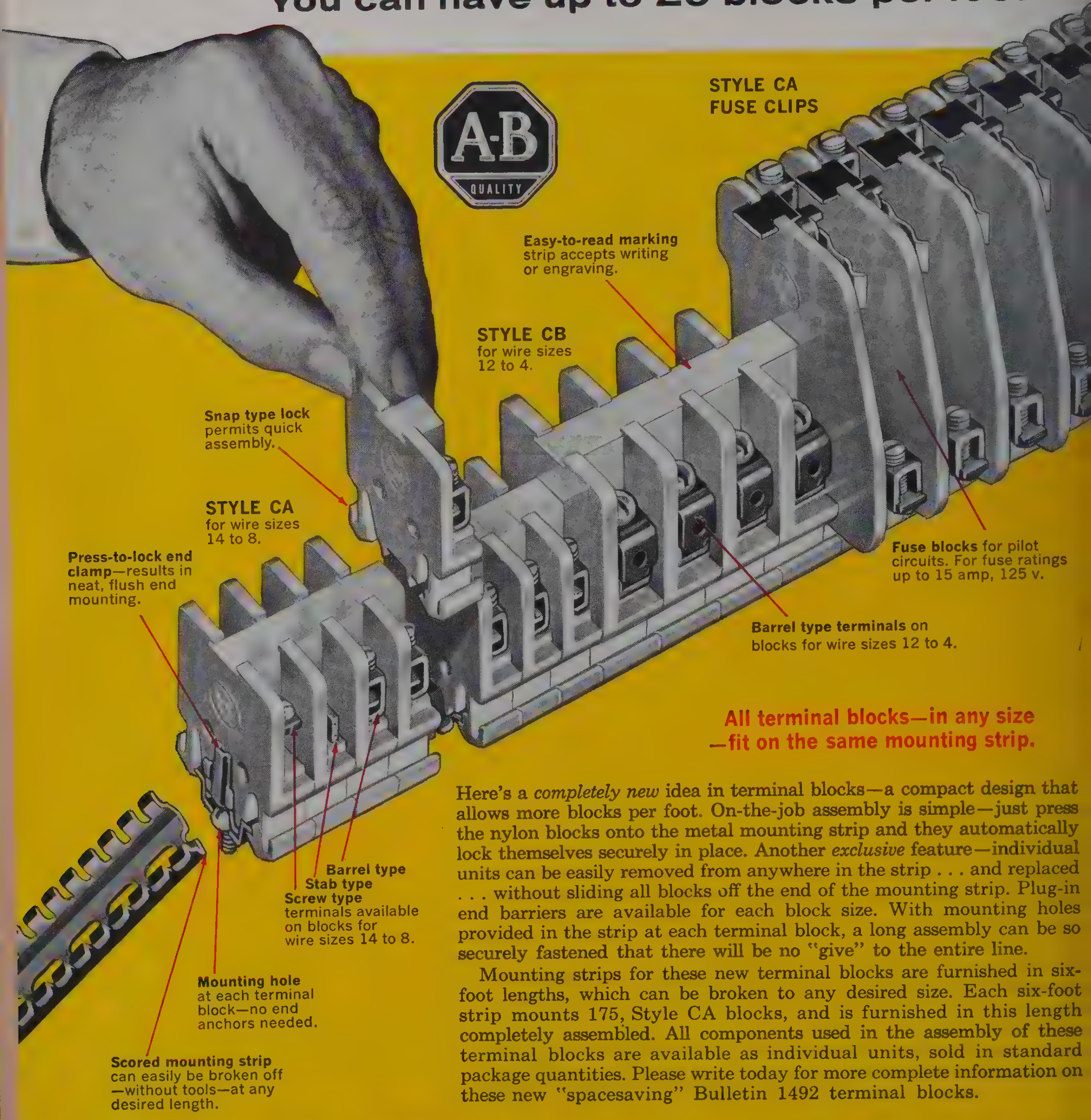
QUALITY MOTOR CONTROL

new

ALLEN-BRADLEY BULLETIN 1492 SNAP-ON TERMINAL BLOCKS

save space

You can have up to 29 blocks per foot


A-B
QUALITY
STYLE CA
FUSE CLIPS
Easy-to-read marking strip accepts writing or engraving.
STYLE CB
for wire sizes 12 to 4.
Snap type lock permits quick assembly.
STYLE CA
for wire sizes 14 to 8.
Press-to-lock end clamp—results in neat, flush end mounting.
Fuse blocks for pilot circuits. For fuse ratings up to 15 amp, 125 v.
Barrel type terminals on blocks for wire sizes 12 to 4.
Barrel type
Stab type
Screw type
terminals available on blocks for wire sizes 14 to 8.
Mounting hole at each terminal block—no end anchors needed.
Scored mounting strip can easily be broken off—without tools—at any desired length.

All terminal blocks—in any size—fit on the same mounting strip.

Here's a *completely new* idea in terminal blocks—a compact design that allows more blocks per foot. On-the-job assembly is simple—just press the nylon blocks onto the metal mounting strip and they automatically lock themselves securely in place. Another *exclusive* feature—individual units can be easily removed from anywhere in the strip . . . and replaced . . . without sliding all blocks off the end of the mounting strip. Plug-in end barriers are available for each block size. With mounting holes provided in the strip at each terminal block, a long assembly can be so securely fastened that there will be no "give" to the entire line.

Mounting strips for these new terminal blocks are furnished in six-foot lengths, which can be broken to any desired size. Each six-foot strip mounts 175, Style CA blocks, and is furnished in this length completely assembled. All components used in the assembly of these terminal blocks are available as individual units, sold in standard package quantities. Please write today for more complete information on these new "spacesaving" Bulletin 1492 terminal blocks.

13-61-RM

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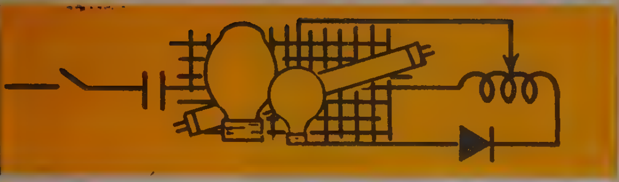
QUALITY MOTOR CONTROL

5



LIGHTING CONTROL

THE most common type of ON-OFF lighting control is manual, direct circuit switching, using wall-mounted wiring switches (mechanical or mercury toggle type), branch-circuit switches or circuit breakers, or panelboard main switches or circuit breakers.

Automatic direct switching of lighting circuits is commonly accomplished by means of time switches. But, there is a growing trend toward the convenience and flexibility of different types of remote-control magnetic switching using relays and contactors.

LOW-VOLTAGE RELAYS

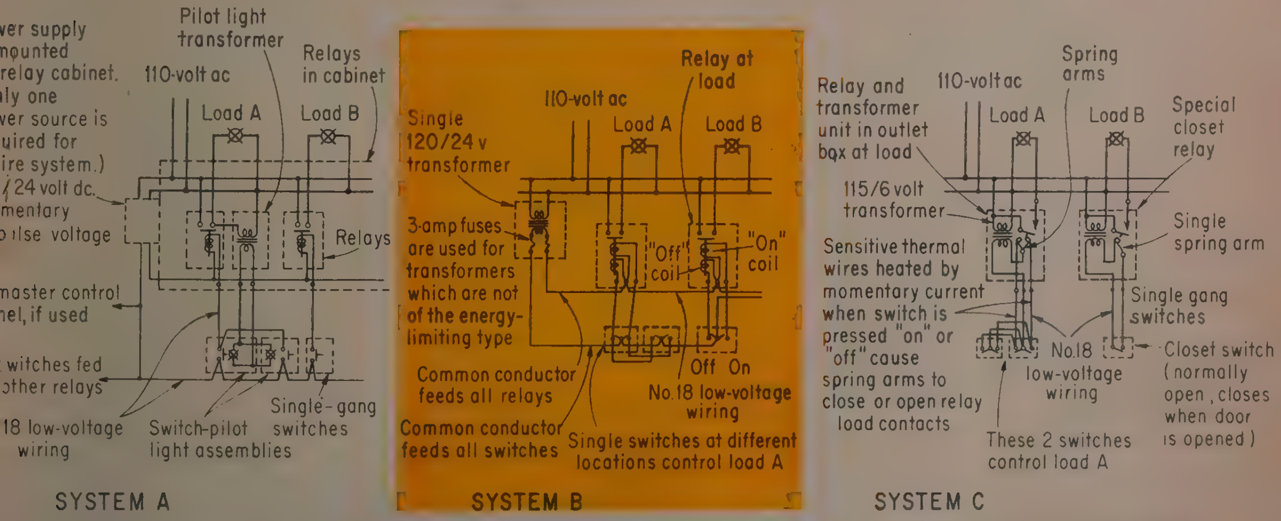
Low-voltage relay switching is used where remote control or frequent individual control is required for each of a number of small 120-volt or 277-volt lighting loads. In this type of control, the relay contacts are used to open and close the hot conductor supplying the one or more luminaires controlled by the relay. The relay is generally a 3-wire, mechanically held, ON-OFF type, energized from a step-down control transformer.

In some cases, all of the relays may be mounted in an enclosure near the panelboard supplying the branch circuits which the relays switch, with a single transformer mounted there to supply the low voltage. Where a single panelboard serves a large number of lighting branch circuits over a very large area—such as large office areas in commercial buildings, a number of relays associated with each section of the over-all area may be group-mounted in an enclosure in that area. Or an individual relay may be mounted in an outlet box to control a single fixture or a group of fixtures. Another type of low-voltage relay system uses combination relay-transformer units, which are mounted in outlet boxes to control single fixtures or groups of fixtures, with the transformer primary connected to the branch-circuit conductors at the relay unit location and low-voltage control wiring carried down to the low-voltage switches for control. Three systems are shown below.

CONTACTOR CONTROL

Use of magnetic contactors to control large blocks of lighting can be made in many ways. One or more contactors may be mounted in a panelboard to control lighting circuits or sections of the bus, or may be mounted in or out of the panel to control the entire panel. Such use can provide remote control of lighting supplied from panelboards in out-of-the-way places. Typical of such application would be the use of a contactor to control an entire lighting panel installed in the space above the ceiling of a convention hall or auditorium to supply the lighting for the main interior. In such a case, a mechanically held contactor would be installed either in the panel or just ahead of it, and its control circuit would be carried down to pilot switches at the floor level or other level at which a lighting control center might be located.

Another contactor application for full panel control might involve locating the contactors at widely spaced lighting panelboards supplying outdoor lighting with all of the control circuits brought to pilot switches at a common point of control. For control of individual circuits supplying lighting loads, contactors may be located near the panelboard or near the load with the control circuit arranged for maximum convenience of operation at any number of points, depending upon the job requirements.

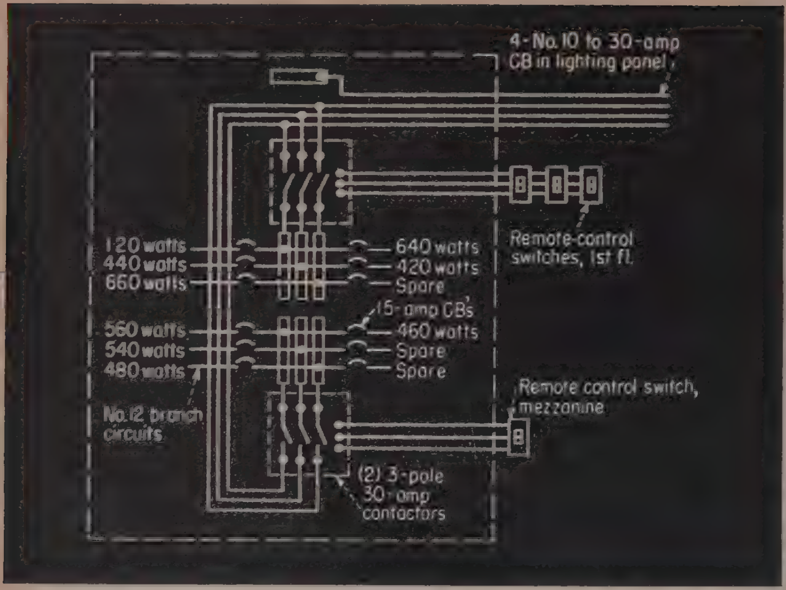

ver supply
nounted
relay cabinet.
ly one
ver source is
uired for
ire system.)
/24 volt dc.
mentary
ulse voltage
Pilot light transformer
110-volt ac
Relays in cabinet
Load A
Load B
Relays
master control
nel, if used
witches fed
other relays
18 low-voltage wiring
Switch-pilot light assemblies
Single-gang switches
Relay at load
110-volt ac
Single 120/24 v transformer
Load A
Load B
3-amp fuses are used for transformers which are not of the energy-limiting type
"Off" coil
"On" coil
Off
On
Common conductor feeds all relays
No.18 low-voltage wiring
Common conductor feeds all switches
Single switches at different locations control load A
Relay and transformer unit in outlet box at load
110-volt ac
Spring arms
Load A
Load B
Special closet relay
115/6 volt transformer
Single spring arm
Sensitive thermal wires heated by momentary current when switch is pressed "on" or "off" cause spring arms to close or open relay load contacts
Single gang switches
No.18 low-voltage wiring
Closet switch (normally open, closes when door is opened)
These 2 switches control load A

SYSTEM A

SYSTEM B

SYSTEM C

LOW-VOLTAGE RELAY switching is available in a number of complete systems, including all of the necessary components—relays, step-down transformers, remote switches, installation hardware.


4-No. 10 to 30-amp CB in lighting panel
120 watts
440 watts
660 watts
560 watts
540 watts
480 watts
No. 12 branch circuits
640 watts
420 watts
Spare
15-amp CB's
460 watts
Spare
Spare
Remote-control switches, 1st fl.
Remote control switch, mezzanine
(2) 3-pole 30-amp contactors

CONTACTOR CONTROL of lighting is shown in this panelboard construction for multi-point remote-control of large blocks of lighting in a library.

LIGHT DIMMING

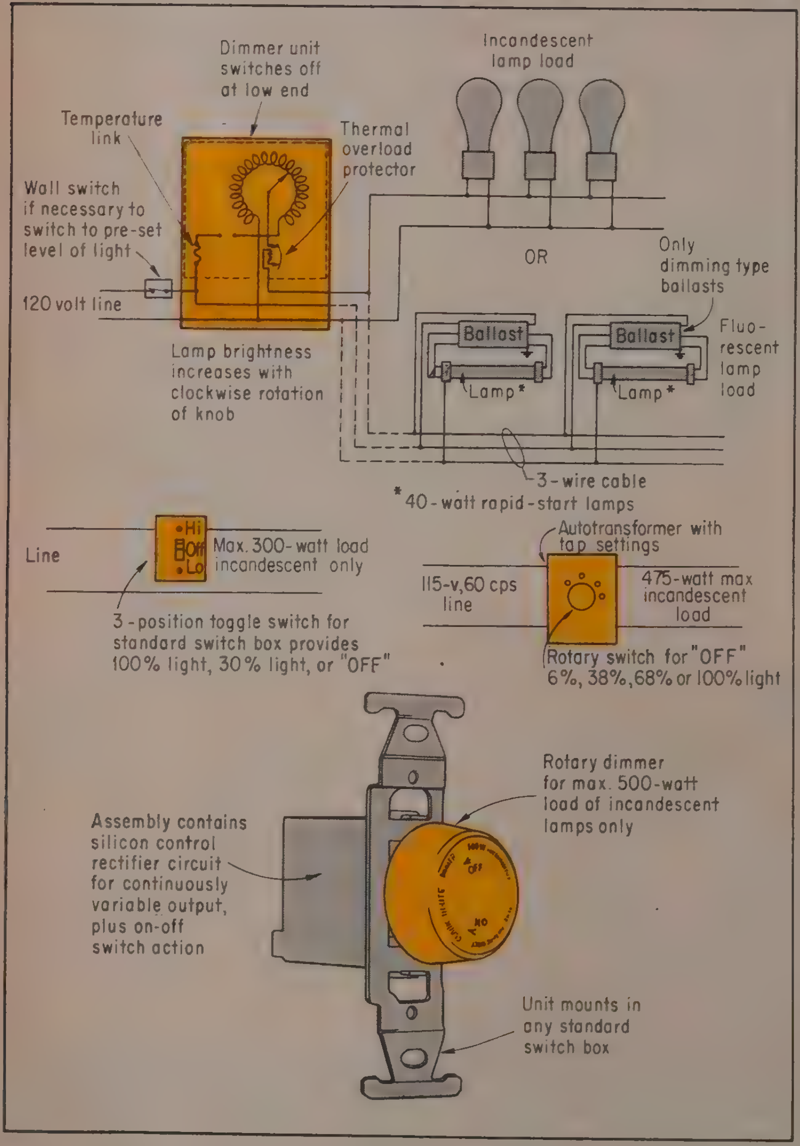
For varying intensity of light output from luminaires, a number of methods and special equipment are available for incandescent, fluorescent and mercury-vapor lighting. The following is a rundown on the different types of dimming equipment:

Autotransformer Dimming—This type of dimming finds wide, practical application on ac circuits only. It consists of an adjustable autotransformer connected across the supply line to the lighting load, with the load connected to the variable low-voltage secondary of the autotransformer. Autotransformer dimmers have low loss, moderate cost, negligible heating and good regulation. Units are available to meet any load requirements. Control is exercised through a rotating wheel handle. For large amounts of power, motor operated autotransformer dimmers are often used, particularly to provide remote control of the unit.

SCR Dimming—A relatively recent addition to the types of equipment available for dimming is the SCR (Silicon Controlled Rectifier) dimmer. Taken all together, its characteristics and present cost make the SCR dimmer a prime candidate for a very wide range of dimming applications. SCR dimmer systems offer: lightest weight, smallest size, highest efficiency, excellent regulation, long life, negligible maintenance, remote control.

The electrical circuit consists of two silicon controlled rectifiers in a so-called "back-to-back" assembly. Each element will permit a controlled amount of current to pass during its half of the cycle.

The controlling device is a pulsing transformer energized from a remotely located potentiometer.


Dimmer unit switches off at low end
Incandescent lamp load
Temperature link
Thermal overload protector
Wall switch if necessary to switch to pre-set level of light
120 volt line
OR
Only dimming type ballasts
Ballast
Ballast
Lamp*
Lamp*
Fluorescent lamp load
Lamp brightness increases with clockwise rotation of knob
3-wire cable
*40-watt rapid-start lamps
Line
Hi
Off
Lo
Max. 300-watt load incandescent only
3-position toggle switch for standard switch box provides 100% light, 30% light, or "OFF"
Autotransformer with tap settings
115-v, 60 cps line
475-watt max incandescent load
Rotary switch for "OFF" 6%, 38%, 68% or 100% light
Rotary dimmer for max. 500-watt load of incandescent lamps only
Assembly contains silicon control rectifier circuit for continuously variable output, plus on-off switch action
Unit mounts in any standard switch box
OFF
ON

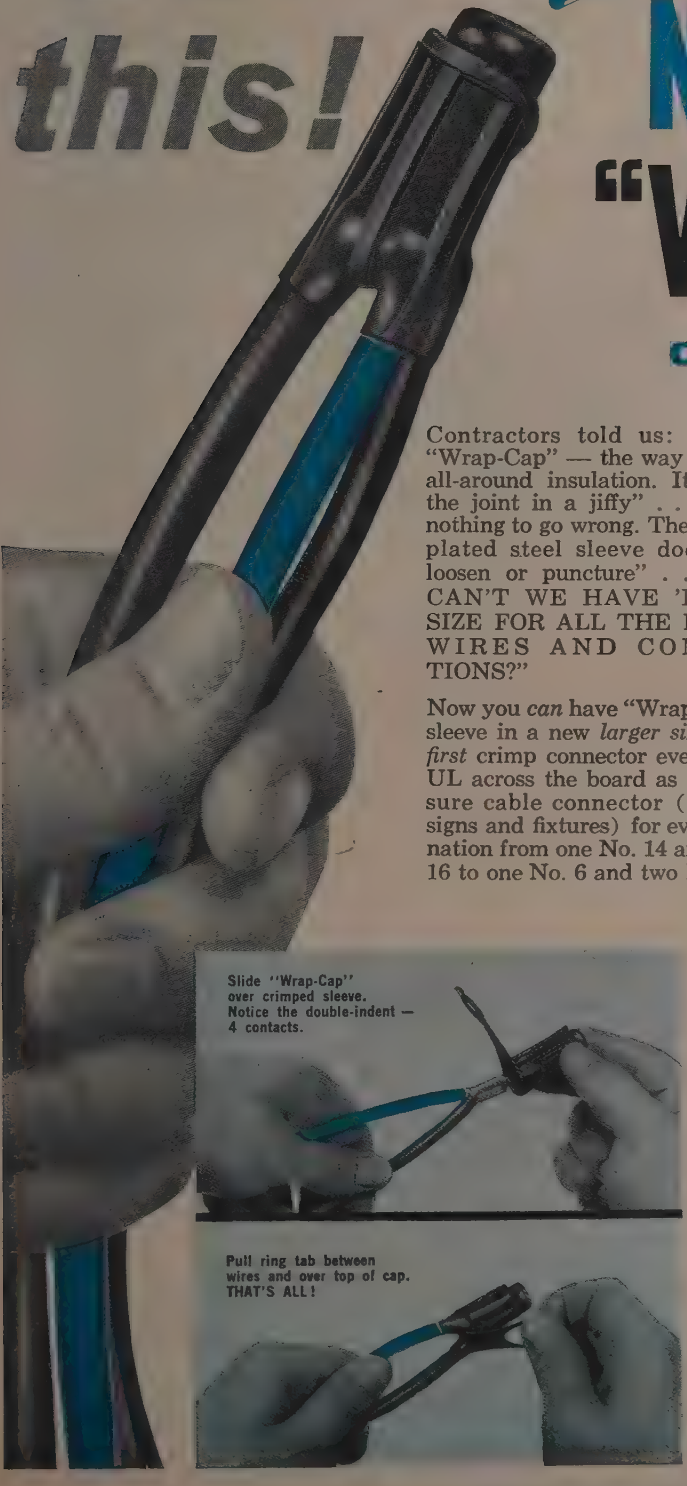
DIMMING CONTROL of relatively small loads of incandescent or fluorescent lighting (typically, up to 1800 watts) may be obtained from a range of available wall-mounting control units. Devices include autotransformers assemblies and units with various semi-conductor circuits.

now get this!

THE NEW CRIMP ESPECIALLY MADE FOR TODAY'S LARGER WIRE SIZES AND COMBINATIONS

NEW SIZE "WRAP-CAP"

CRIMP CONNECTOR



Slide "Wrap-Cap" over crimped sleeve. Notice the double-indent — 4 contacts.

Pull ring tab between wires and over top of cap. THAT'S ALL!

Contractors told us: "We like "Wrap-Cap" — the way it gives us all-around insulation. It wraps-up the joint in a jiffy" . . . "There's nothing to go wrong. The cadmium-plated steel sleeve doesn't slip, loosen or puncture" . . . "WHY CAN'T WE HAVE 'EM IN A SIZE FOR ALL THE BIG NEW WIRES AND COMBINATIONS?"

Now you *can* have "Wrap-Cap" and sleeve in a new *larger size*. It's the *first* crimp connector ever listed by UL across the board as 600V pressure cable connector (1000V for signs and fixtures) for every combination from one No. 14 and one No. 16 to one No. 6 and two No. 8. Can be used in 1027 combinations of solid and/or stranded wires in all!

You'll get the same kind of diaper-wrap insulator that contractors have bought by the millions. Only now it's stronger than ever and triple-ribbed for extra tension, with a wider, longer skirt.

And you'll get the same vibration-proof cadmium-plated steel crimp sleeve you've proved best under all conditions. Only now it's longer, to give you *double* indents (4 contacts) at right angles to the wire, can't ever slip or loosen.

No tools needed except regular Ideal Electricians Pliers with crimping die.

FOR THE BEST CRIMP CONNECTOR YOU'VE EVER SEEN OR USED, CALL YOUR IDEAL DISTRIBUTOR OR TRY IT AT OUR EXPENSE.

SOLD THROUGH AMERICA'S LEADING DISTRIBUTORS
IN CANADA: Irving Smith, Ltd., Montreal

MAIL COUPON FOR FREE SAMPLES TODAY!

IDEAL

IDEAL INDUSTRIES, INC. 1041-G Park Ave., Sycamore, Ill.
Please send samples of your new size "Wrap-Cap" crimp connector.

Name____________________________

Company____________________ Title________

Address____________________________

City________________ Zone____ State________

The control-signal circuit operates at 28 volts dc, with currents in the order of milliamperes.

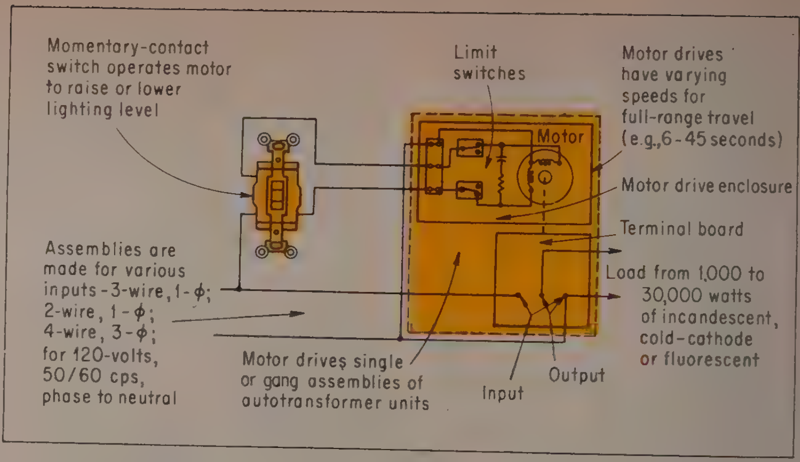
The silicon-controlled rectifier has a very low forward resistance which accounts for its high operational efficiency, which is 98.5%. This low forward drop also makes possible a voltage drop across the dimmer of only a few volts at full load. This results in regulation of about 98%.

Recently, some small unit dimmers utilizing semi-conductor devices and silicon controlled rectifiers have come into the market. These offer wide application in residential, commercial and institutional electrical systems for continuously variable dimming control of relatively small (typically, 500 watts) incandescent lighting loads. Such units are very efficient and compact, providing ready and simple installation in a standard switch box. Only two wire connections have to be made—controlling the hot leg to the load—affording direct replacement of standard toggle switches for new construction or modernization.

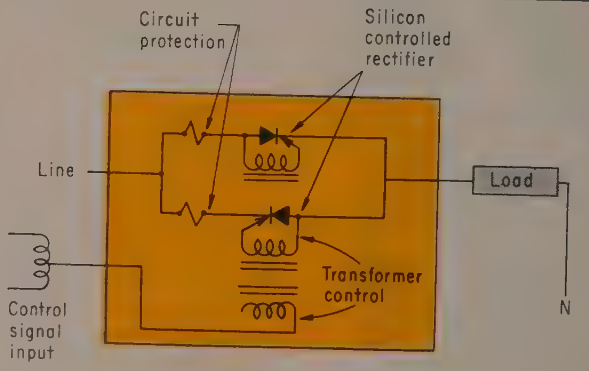
Electronic Dimming—Packaged equipment is available using electronic tubes to provide light-dimming circuits. Such equipment affords great flexibility and remote control, but is relatively expensive due to the extensive circuitry of the equipment.

Magnetic Amplifier Dimming—This dimming method is based on the same general principles as the old saturable core reactor type dimmers used in the past. The old dimmers were slow-acting devices. The magnetic amplifier equipment now available is quick acting, and it combines many desirable dimming characteristics.

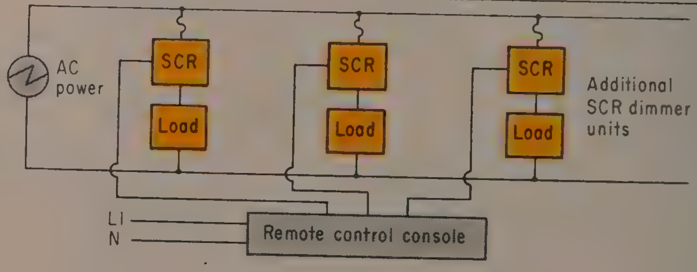
Saturable Core Reactor—A new 2-piece dimming unit for incandescent or fluorescent lamps utilizes the saturable core reactor principle. In this unit, the impedance of a reactor is varied by controlling the amount of direct current fed to a control flux-saturating winding on the reactor core. One part of the unit is a small control pack with a rotary handle, for ready mounting in a standard switch box. This control unit is simply connected to the reactor assembly which can be mounted in any convenient, out-of-the-way place, e.g., in a closet, in the ceiling, etc.


Momentary-contact switch operates motor to raise or lower lighting level
Limit switches
Motor drives have varying speeds for full-range travel (e.g.,6-45 seconds)
Motor
Motor drive enclosure
Terminal board
Assemblies are made for various inputs-3-wire, 1-ϕ; 2-wire, 1-ϕ; 4-wire, 3-ϕ; for 120-volts, 50/60 cps, phase to neutral
Load from 1,000 to 30,000 watts of incandescent, cold-cathode or fluorescent
Motor drives single or gang assemblies of autotransformer units
Input
Output

AUTOTRANSFORMER DIMMERS for control of incandescent, fluorescent or cold cathode lighting in commercial and institutional interiors—theatres, schools, churches, stores—are available in manually operated or motor-driven assemblies of one or more autotransformer units. As shown, a momentary-contact switch is usually used to energize the motor to select the tap setting for desired light output. Positioner controls are available for use with motor-driven dimmers for calibrated scale settings of light output from the controlled lighting units. Still another type of control available consists of compatible control elements which provide automatic control of light output from controlled lamps in response to a light-sensitive photocell control hookup. In this automatic system, intensity of artificial light is controlled to provide a constant lighting level in those places where a combination of daylight and artificial light is used to effect the total lighting result.

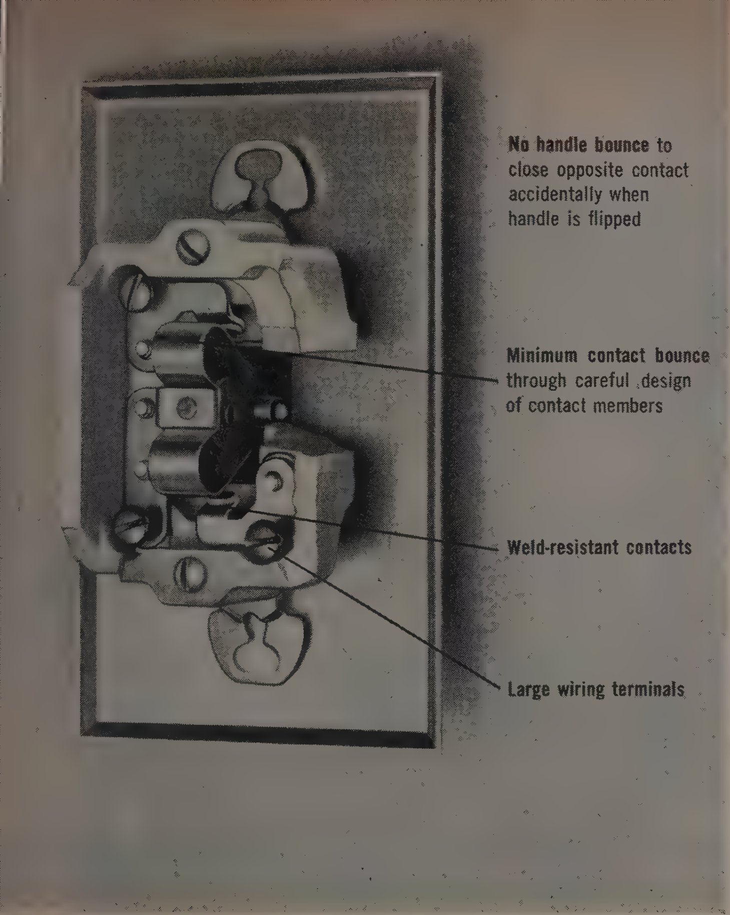


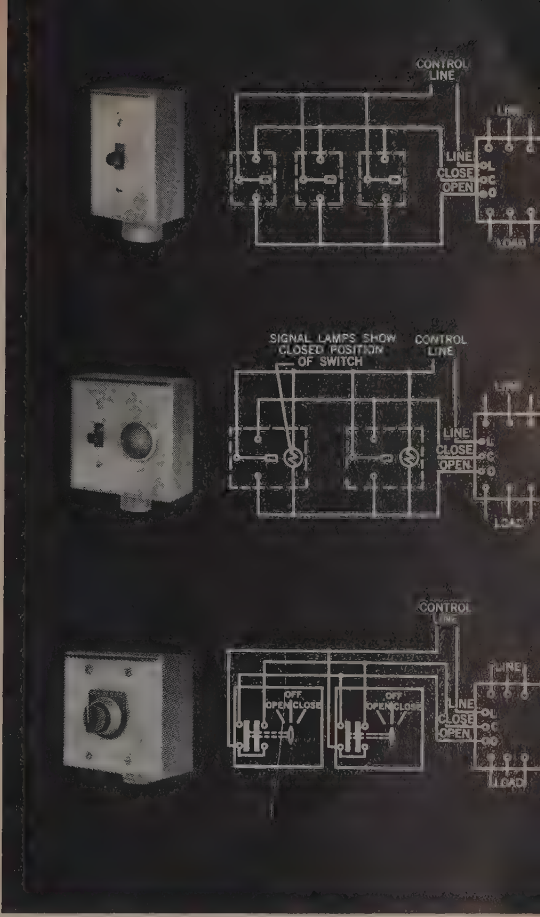
BASIC SILICON CONTROLLED RECTIFIER CIRCUIT FOR DIMMING



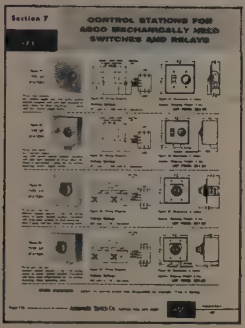
BLOCK DIAGRAM OF SCR DIMMER SYSTEM

SILICON CONTROLLED RECTIFIERS are the basic elements of a relatively new type of light-dimming control. These devices are used in series with the lamp load in such a way that a control signal applied to a control electrode of each rectifier determines the amount of current fed to the load and thereby regulates the brightness of the lamps. Typical available SCR units are rated at 4000 watts and 10,000 watts. They can be operated from 60-cycle ac lines supplying: 120 volts, single-phase; 120/240 volts, 3-wire, single-phase; or 120/208 volts, 3-phase, 4-wire.


No handle bounce to close opposite contact accidentally when handle is flipped
Minimum contact bounce through careful design of contact members
Weld-resistant contacts
Large wiring terminals



NOW! NEW ASCO CONTROL STATIONS FOR MECHANICALLY HELD SWITCHES


Section 7

CONTROL STATIONS FOR ASCO MECHANICALLY HELD SWITCHES AND RELAYS

Write for detailed information on the application of these control stations; or for complete specifications, circuit diagrams, and dimensioned outline drawings.

Four Vital Features Ensure Perfect Performance—Specifically designed for all applications involving mechanically held switches, these rugged new stations are the latest addition to the ASCO line of fine control mechanisms. The new units combine four built-in construction refinements essential to top performance in a control station. **1** **Momentary-Contact Action** permits control from any number of conveniently located stations—single-pole double-throw design provides both opening and closing control. **2** **Inherently Interlocked Construction** with contact arrangement actuated by a single toggle prevents simultaneous closure of both circuits. **3** **Extra-Heavy Contacts** handle the high inrush currents typical of most solenoid coil circuits. **4** **Conventional External Configuration** fits standard wall boxes and matches standard wall switches for flexibility of location; ease of installation.

ASCO Bulletin 173 Control Stations are tested and certified for control of any ASCO Mechanically Held Switch. They are available in flush or surface mounting styles, in the following types:

- Three-position, neutral center, toggle type; 277 volts ac, 250 volts dc—with or without pilot light
- Three-position rotary selector switch with spring return to neutral center; 600 volts ac or dc

ASCO Electromagnetic Control ASCO

DEPENDABLE CONTROL BY Automatic Switch Co. 50J HANOVER RD., FLORHAM PARK, N. J. • FRONTIER 7-4600 • AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

Only ADVAN guard®

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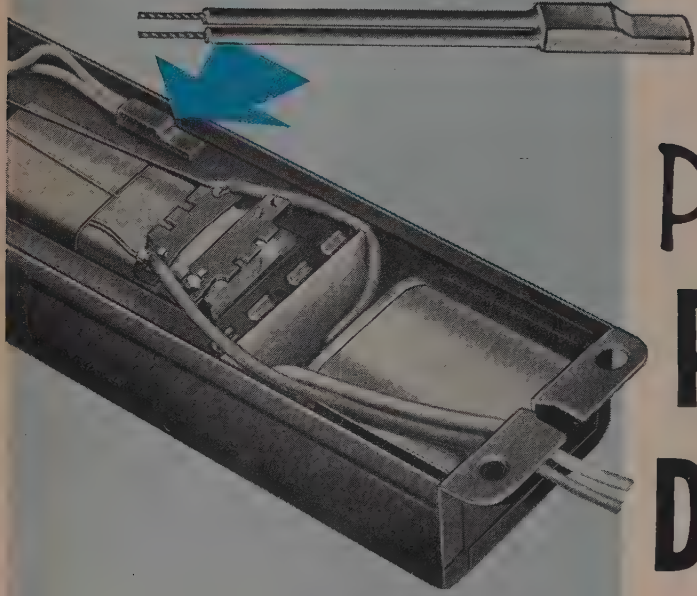
RE-SETTING
THERMOSTAT



Protects against PREMATURE DESTRUCTION

OF FLUORESCENT LAMP BALLASTS . . . AND ELIMINATES THE NEED FOR INDIVIDUAL FUSING.

ADVAN-guard® protects fluorescent lamp ballasts against premature destruction and costly replacement by protecting against abnormal operating temperatures due to incorrect voltage supply, excessive current, lamp rectification, internal ballast short circuiting, inadequate lamp maintenance and improper fixture application.

ADVAN-guard®, a thermally actuated protective thermostat sealed in the ballast housing, automatically 'trips-out.' whenever the ballast operates at abnormal temperatures from any internal or external cause. Unlike other protective devices which permit premature ballast destruction by cutting the ballast out of the line only after it has been destroyed, ADVAN-guard® cuts out before heat can cause premature destruction, resets automatically when the trouble has been corrected and permits the ballast to resume normal operation.

Don't settle for one-time protectors that destroy fluorescent lamp ballasts after a single cycle of abnormal temperatures . . . insist on ADVAN-guard® equipped fluorescent lamp ballasts for safety and longer life.

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ADVANCE® TRANSFORMER CO.

CBM CERTIFIED by E.T.L.

WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF FLUORESCENT LAMP BALLASTS

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Package Substations Cut Costs

Philadelphia shopping center installation provides comparison with custom-engineered assembly.

CUSTOM SUBSTATION above is compared with packaged substation below. Both are 300-kva installation.

SECONDARY POWER is distributed from free-standing switchboard with fusible Vacu-Break switches.

INSTALLATION time and labor costs cut by two-thirds, savings of 40% in space required, improved safety and reduced need for maintenance were among the advantages cited for packaged electrical substations at the Northeast Shopping Center, in northeast Philadelphia, Pa.

The job furnishes an excellent example of the benefits of packaged units because the center's distribution system incorporates both packaged and custom-engineered substations, involving separate components, assembled on the site. Supplied by I-T-E Circuit Breaker Co., Philadelphia, both types of equipment were installed at the same time by electrical contractors Morris Newmark and Bro., Inc.

Three of the substations are Tranfo-Unit packaged installations, the fourth is a substation utilizing single-phase transformers and separate primary switch, with busduct and cable ties on the secondary side. A unique opportunity for side-by-side comparison is provided because the custom-engineered substation and one of the packaged units have equivalent 300-kva ratings.

The electrical contractor, comparing a packaged unit with the custom-engineered equipment, both of 300-kva capacity, reports the Tranfo-Unit was installed by two men in one-third the time required for installation of the other equipment, and at a substantial saving (about ⅔) on labor costs. Initial cost of the units was about the same.

The 300-kva package unit required 144 sq ft of space (18 by 8) as against 240 sq ft (16 by 15) for the custom-engineered 300-kva installation. With space at a premium for dock loading, parking, and driveway needs, the 96 ft saved is significant. With no exposed high- or low-voltage points, the completely metal-enclosed unit required only minimal fencing.

The Northeast Shopping Center consists of some 30 supermarkets, department stores, specialty shops, restaurants, and service establishments. Power is brought in from Philadelphia Electric Company lines at 13,200 volts.

An interesting sidelight is that, in this instance, the Center purchases bulk power from Philadelphia Electric Company, in turn metering each tenant and charging each the same rates they would pay Philadelphia Electric Company for actual power consumed. The power company sells, as it prefers to sell, bulk power; the tenants pay no more; and when the distribution equipments costs have been amortized, within a few years time, the margin between the cost of the bulk rate electricity and the amount paid by tenants, on the basis of actual usage, becomes a supplemental source of revenue.

Power enters the area, at the 13.2 kv supply, through metalclad switchgear. From this central point, power is fed at 13.2 kv to a (1) 1000-kva package substation which supplies 120/208 volts to various stores; (2) a 1500-kva package substation supplying 480/277 volts to a large department store and power for outside lighting; (3) a 300-kva package substation supplying a group of stores; and (4) a 300-kva custom-engineered substation which supplies power to a supermarket.

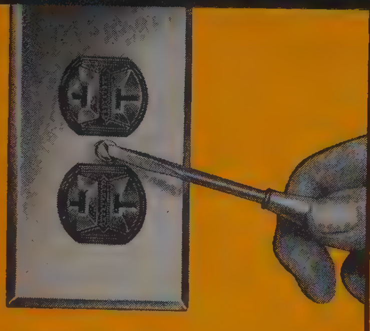
Secondary power from these various substations feeds to distribution power panels within the various buildings.

When additional electrical capacity is needed later, it will be available from present equipment. In initial engineering of the installation, provision was made for fan-cooling transformers which will permit the 1000-kva unit to deliver 1150 kva.

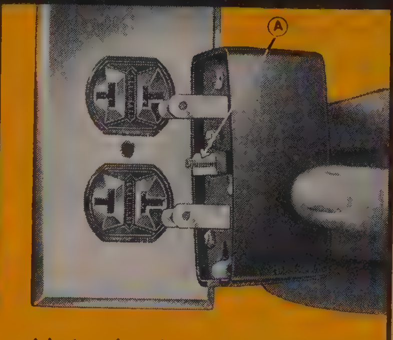
The custom-engineered 300-kva equipment was specified by the supermarket because of its desire to continue with similar equipment selected for its other facilities.

Architects on the over-all Northeast Shopping Center project were Neumann & Taylor, of New York City. George W. Neff, Philadelphia, was architect for a large department store and for a supermarket at the center. Consulting engineer was Sidney W. Barbanel of Long Island City, N. Y.; Morris Newmark and Bro., Inc., Philadelphia, was electrical contractor on the project.

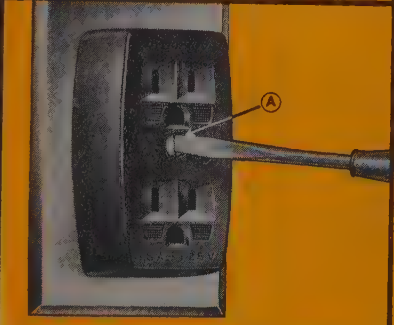
HUBBELL DUPLEX ADAPTER
15 A., 125 V.



Hubbell Duplex Adapter No. 5291 is easy to attach. Just remove screw holding metal or plastic plate to 2-wire receptacle. Leave plate in place.



Adapter plugs into 2-wire receptacle. Screw A will go through plate to grounded box. It is connected to both U-slots of adapter.



Tightening Screw A establishes adapter ground in a grounded system. If the system is ungrounded, connect adapter as shown at right.

When an existing system is not properly grounded, the adapter may be grounded by connecting a grounded wire to green hex Screw B.

FAST TEMPORARY CONVERSION TO 3-WIRE GROUNDING SAFETY

This polarized, plug-in adapter converts 2-wire duplex receptacles used with grounded or ungrounded systems to temporary 3-wire grounding receptacles. Landlords find it a great convenience when tenants requiring 3-wire facilities cannot postpone occupancy until rewiring is completed.

To make a conversion, nothing in the existing system has to be removed except receptacle cover-plate screws, to make room for a captive screw in each adapter. This captive screw acts as a conductor from the two U-slots to the grounded system. For use with receptacles in ungrounded systems, there is a green binding screw to permit connection of an independent ground wire. Either way, the electrically independent blades and contacts continue existing split circuits.

The polarized adapter operates in any parallel or T-slot duplex receptacle with metal or plastic cover plates. Brown or ivorine bakelite, for 15 amperes, 125 volts. Size: 1.4″ from plate, 3.3″ high, 1.75″ wide.

HARVEY HUBBELL INCORPORATED
Bridgeport 2, Connecticut
In Canada: Scarborough, Ontario

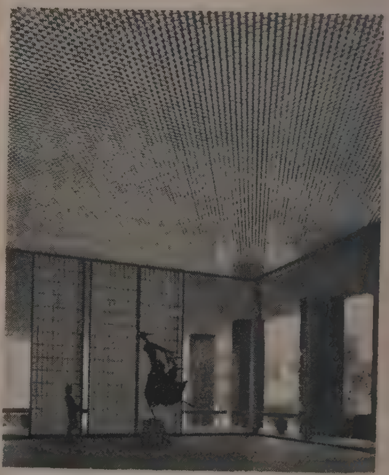
Acrylic Plugs in Brass Pans Provide Novel Lighting

A modern office structure with an unusually distinctive lobby is the Crown-Zellerbach Building in San Francisco, where a perforated brass ceiling above the huge glass-enclosed entrance foyer contains nearly 17,000 cast acrylic plugs which are top-lighted by continuous rows of slimline lamps spaced a foot apart and positioned a foot above the plane of the suspended metal ceiling.

The result is spectacular, because light from above is transmitted through the clear plugs to their lightly sanded bottoms; plug ends thereby glowing in a brilliant yet subdued pattern of uniform luminosity.

As noted in the construction photo, the basic brass ceiling pans are formed in shapes of diamonds; being framed with backing angles and rod suspended from inserts in the overhead concrete slab. The ceiling area so treated measures 52 by 30 ft, with 450 brightly polished red brass sections combined in the over-all assembly.

Perforations in these sections are 2 in. in diameter, spaced on 4-in. centers in a triangular configuration. Acrylic plugs inserted through the perforations likewise measure 2 in. both in diameter and depth, bottoms being sanded as noted above, and tops being capped by square acrylic sheets which are cemented in place to serve as



UNUSUAL CEILING DESIGN consists of 17,000 cast acrylic plugs set in perforated brass ceiling with back-lighting provided from continuous rows of 8-ft slimline fluorescent lamps mounted a foot apart and a foot above the suspended metal surface.

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- **RIGID STEEL CONDUIT**
  HOT DIPPED GALVANIZED
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"Darn right! I've been very happy with Leviton on the last two jobs. And this may mean the third."

This typical wholesaler-contractor conversation at bid time is being repeated 'round the country. Leviton's line of specification grade devices have caught on.

Everyone is pushing Leviton because of the delivery, the price, the completeness of line and the consistent quality. Architects and engineers have the confidence to specify Leviton on their biggest projects.

NO. 5521

Quiet Switch in 15A.-120-277V.A.C. only and 20A.-120-277V.A.C. only

HIGH CAPACITY will accommodate the high inductive loads of fluorescent systems, or full rated capacity of tungsten filament lamp loads. Take full load currents up to 80% of the switch rating for motor control.

LEVITON QUALITY
TALKS BUSINESS

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LEVITON MANUFACTURING CO., INC.,
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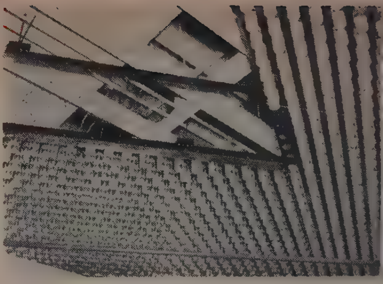
Contact American Insulated Wire Corp., Pawtucket, Rhode Island, a Leviton subsidiary, for a complete line of insulated wire and cable products.



REMOVAL OF SECTION in ceiling shows diamond-shaped formation of brass sections and triangular configuration of acrylic plugs. Plugs are lightly sanded at the bottom to diffuse light from overhead lamps, while square acrylic sheets are cemented to plug tops to prevent them from slipping through the metal pans.

hangers for the plugs themselves.

Due to the nature and highly polished sides of the transparent plugs, little light is emitted laterally, the result being that the glowing bottoms stand out prominently in this unique approach to decorative illumination.

Credit for the novel design belongs to Skidmore, Owings & Merrill and to Hertzka & Knowles, associated engineers and architects. Ceiling panels were provided by the Cadillac Plastic & Chemical Co., while electrical components were installed by the joint-venture team of Charles A. Langlais and Ets-Hokin & Galvan, both contractors with headquarters in San Francisco.

Armored Cable and Conduit for Feeder Circuits

The side-by-side installation of aluminum interlocked armor cable and a more conventional aluminum conduit-copper cable feeder system is an interesting electrical feature of Fort Worth's new First National Bank building. These somewhat "competitive" types of systems were both used to economic advantage by Ashe Electric Company in installing the main feeder layout of the 22-story structure and adjacent 5-story parking garage.

The 3-conductor, 600-volt interlocked armor cables (500 MCM and 750 MCM) serve upper floors while several of the lower floors are fed from copper cable in aluminum conduit. Pulling individual armor cables from the main panel room in the basement to the 20th floor took only 25 minutes and four men

Better makin's

...better packin's!

HYLUGS **ONE PIECE PURE COPPER** means a solid, low-resistance connection for junction box, panels and motor control work— **SEAMLESS BARREL** means you can crimp anywhere on the barrel—**FLIP-TOP BOX** means handy shirt pocket size—you get the Hylugs® you want when you want them... no fumbling... all the connector facts right on the box.

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Insist on genuine Hylugs in flip-top boxes!

T86E Honeywell Round. The high-style T86E provides night setback when used with either of the control panels shown. Use the T86 C or D without a control panel when night setback is not desired. Unmatched rapid cycling in all three provides the ultimate in electric heating control.

R8097 Relay

New W476 Control Center. This attractive Control Center permits manual control of night temperature setback for any or all of the thermostats in the system. Control system is designed with rotary switches—each capable of adjusting one or two T86 E zone thermostats. Models are available with three to five switches.

T832 *Day-Nite Round.* Unique thermostat features handy manual setback, automatic heat pick-up—day and night.

T87 *Heating-Cooling Thermostat.* With new finish, larger numerals. Same streamlined styling as the T86 Round.

T88B *Thermostat.* High-style economy thermostat with selectable heat anticipation and mercury switch operation.

T83A *Thermostat.* For budget-minded customers, a two-wire, low-voltage thermostat, with snap acting contacts.

The W489 Honeywell Weather Station.* Now your customers can control indoor comfort and check outside weather conditions at a single central location. New low-voltage system lets homemakers pre-set day and nighttime temperatures for completely automatic or remote manual control with up to ten zone thermostats. Check indoor humidity and both outdoor and indoor temperatures at a glance.

Bring out the best in Electric Heating with HONEYWELL LOW VOLT CONTROLS!

Versatile R8097 Relay makes possible the widest range of control combinations ever offered the electric heating industry.

This completely flexible relay works perfectly with Honeywell low voltage thermostats or central control panels, giving your customers a choice of the ultimate in electric heating controls. These deluxe controls are engineered and designed especially for electric heating and they give you every assurance of top performance, top profits. What's more, you get immediate customer acceptance because of Honeywell's long established reputation for quality.

Total flexibility is yours when you feature the Honeywell line! In addition to the relay coupling with the top of the line, the R8097 is also adaptable to each of the wide selection of standard thermostats shown below. For further information on these—or on the finest in line voltage thermostats for electric heating—call your nearest Honeywell office. Or, write Honeywell, Dept. *EC-7-81,* Minneapolis 8, Minn. *Sales and service offices in all principal cities of the world.*

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First in Control

SINCE 1885

T861 *Heating-Cooling Electric Clock Thermostat.* A deluxe control for year-round automatic day-night comfort.

Indoor-Outdoor *System.* T846A outdoors senses temperatures; T855A indoors compensates for changes.

T852 *Electric Clock Thermostat.* A deluxe thermostat providing completely automatic day and night heating comfort.

T870 *Heating-Cooling Thermostat.* A deluxe family that satisfies the complete range of heating-cooling needs.

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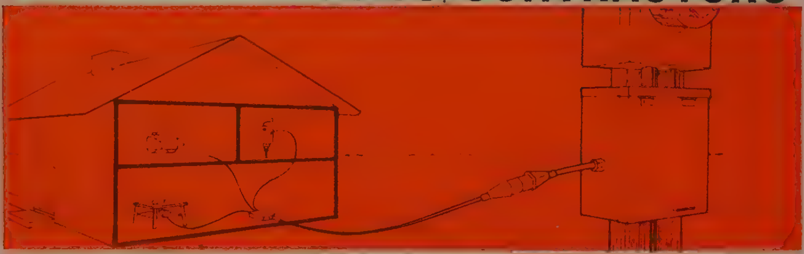
WB TUFFLINE Power Systems carry electric power from temporary service or portable generators wherever needed at construction sites.

These systems are made of rugged 3 conductor DYNAPRENE SO cord permanently molded to tough, waterproof neoprene connectors.

Extensions are available so that additional length and additional outlets are obtainable.

Write for complete details in Bulletin TL-2 . . . it's free.

. . . TO CONTRACTORS



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TWO FEEDER TECHNIQUES, interlocked armor cable and conductors in conduit, found economical, highly effective application in this 22-story office building.

INTERLOCKED ARMOR CABLE offered substantial labor savings in its use for feeders to the higher floors of the 22-story building.

stationed at different locations. For these major reasons, a total of 7000 ft of aluminum interlocked armor cable was specified for service to upper floors. A total of 160,000 ft of conduit, ranging in diameter from $\frac{3}{4}$ in. to 5 in. was also used on this job to serve the load concentrations on lower floors.

The building's electrical system was designed by the engineering firm of Yandell, Cowan and Love of Fort Worth. Associated architects were Preston M. Geren, Fort Worth and Skidmore, Owings and Merrill, New York City.

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lighting

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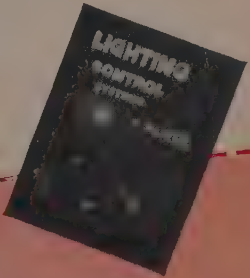

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Space savingest relay you've ever seen!

300 V. control relay so reliable it's permanently sealed

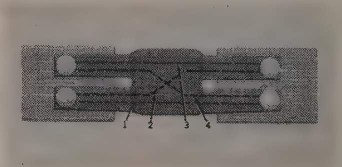
Here's the best answer yet to the need for an extremely reliable, compact 300 V. industrial relay—the new Cutler-Hammer "Compact 300"—up to 24 poles in an area less than a dollar bill in size.

This relay has proved so reliable we've permanently enclosed it. If it should be damaged by a fault current, it's priced so you can throw it away and replace. The "Compact 300's" low price makes this the practical, economical maintenance procedure.

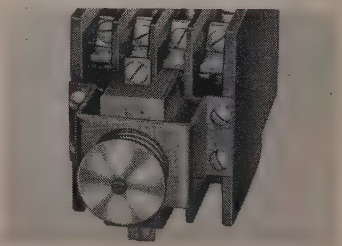
Think of the ways you can save needed space with this relay. Controls up to eight circuits in panel space only 2″ wide by 2¾″ high. 2, 3, 4, 6 and 8 poles with any combination of N.O. or N.C. contacts available.

There are many other exclusives in the "Compact 300" . . . call your local sales office for a demonstration. Or write for Pub. LO-79-H241.

WHAT'S NEW AT CUTLER-HAMMER? New and better products like the 300 V. relay are the order of the day at Cutler-Hammer this year. For helpful new ideas in all phases of electrical control planning, call on your Cutler-Hammer distributor or representative.



Greater contact reliability. Parallel bifurcated contacts allow 4 current paths instead of 1, provide much greater circuit reliability. Designed so any current path carries full rating.



Another bonus. "Memory latch" as reliable as the relay itself. No adjustment ever needed . . . add latch at any time.

WHAT'S NEW? ASK...
CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Cutler-Hammer Canada, Ltd.; Cutler-Hammer Mexicana, S. A.

CONTROL

Shielded Fluorescents Operate at 2000 MA in West Coast Freezer Room

Use of standard fluorescent fixtures under internationally created low-temperature conditions is normally avoided, although in the freezer room of the West Coast Grocery Co., Tacoma, Wash., such an installation is effectively used to provide 25 footcandles of average illumination for frozen food products, which are vertically stacked throughout the area of the freezer room.

Protection against the 25-degrees-below-zero environment is obtained by equipping 4-lamp fixtures with Plexiglas enclosures, then using 1000-ma cold-weather ballasts in connection with rapid-start high-output lamps. This procedure eliminates the general objection to the use of fluorescent luminaires in low-temperature applications, thus adding another outlet for this type of lighting.

In this installation, 57 fixtures are mounted at a height of 20 ft in a 20- by 10-ft pattern.

PLEXIGLAS-ENCASED 4-lamp fluorescent fixtures mounted at 20-ft height in 20- by 10-ft pattern provides 25-fc of illumination in this sub-zero freezer room in Tacoma, Wash.

And, since this fluorescent installation utilizes less power per lumen output than a comparable incandescent installation, heat emission from fixtures is minimized, a desirable plus-factor in an area such as this where maximum refrigeration effect is desired. An interesting sidenote pertains to contractor cooperation, for although the lighting assignment was given to Connors Electric, this solution was volunteered by Charles Fields of the Love Electric Co., also of Tacoma, Washington.

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H1H3-H2H4
H1 - H4
240
X2 X3
X1 - X4
120
X1X3 X2X4
X1 - X4
240/120
X2 X3
X1 - X3 - X4
*3 WIRE
SEC.
X4
X2
X3
X1
H1
H3
H2
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WESTINGHOUSE ELECTRIC CORPORATION
MADE IN U.S.A.

New Westinghouse Dry-Type General Purpose Transformers with Rezildur

Westinghouse dry-type EP and EPT transformers stay on the job year after year, handling normal loads and unpredicted overloads with ease.

These transformers are protected by Rezildur,* an outstanding insulation system developed by Westinghouse research. Reliability of the Rezildur insulation system has been thoroughly established using the new proposed AIEE thermal life evaluation test (picture below). The result is transformers offering durability, long life and guaranteed performance.

Dry-type EP and EPT transformers are the smallest, lightest, quietest designs you'll find . . . surprisingly fast and easy to install indoors or out in practically any position. Low cost, too. Ratings are 25, 30 kva and below, single and three phase, 600 volts and below; 15 kva and below, single and three phase, 5,000 volts and below. Your nearby Westinghouse representative has full details. Or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

*Trademark

Thermal life of a transformer is accurately determined by this new proposed AIEE test which makes an accelerated life evaluation. Results have conclusively established the reliability of Rezildur-insulated EP and EPT transformers over a long field life.

Westinghouse EP and EPT dry-type transformers with Rezildur insulation are Underwriters Laboratories, Inc., approved and meet NEMA standards.

J1-70960

Westinghouse

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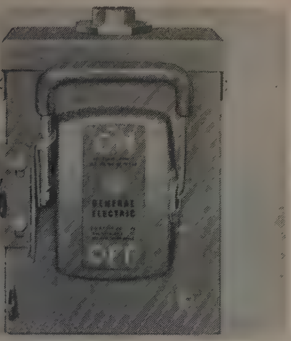
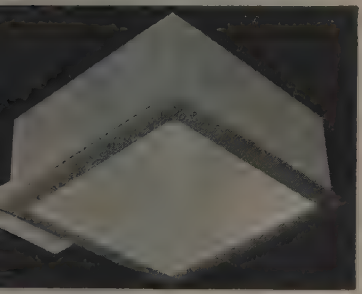


afety Switches (1)

A complete raintight line of red-
andled safety switches, 30 to 60
mps, light and heavy duty, Types
G and TH has been announced.
isted by UL, the devices provide
ne same performance and safety
haracteristics as the indoor,
EMA Type 1 line, including the
eavy-duty ability to withstand
00,000-amp short circuits. Provi-
on for interchangeable raintight
onduit hubs has been made in de-
ces up to 200 amps; 400- and 600-
mp models, standard with blank-
p endwalls, can be ordered with
½-, 3-, 3½- or 4-in. hubs installed.
oth light duty, Type TG and
eavy duty, Type TH, are available
the same ratings as indoor de-
ces: 30 through 600 amps, 240
nd 600 volts ac.

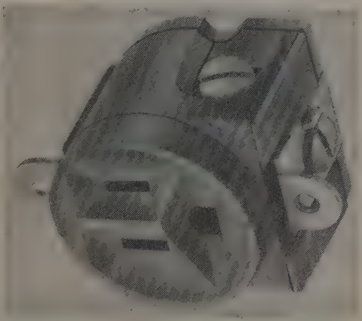
*General Electric Co., Circuit
rotective Devices Dept., Plain-
lle, Conn.*



ighting Fixture (2)

In a new recessed incandescent
ghting fixture line, the Park
quare, provides a choice of three
nielding elements and a wide
nge of finishes for residential,
ommercial and institutional in-
eriors. Basic housings in 100-
att, 150/200-watt and 300-watt
zes are designed to accept any
ombination of face frames and
nielding. Five new face-frame
nishes have been developed. They
are gold-anodized aluminum, satin-anodized aluminum, brass, chrome and white enamel. Features include easy installation in new or existing ceilings; bonderized steel parts for corrosion resistance; and Ever-tite spring hinges for maintenance and relamping. Junction box is prewired and accessible either from inside or outside the housing. Unit meets requirements of UL and NBFU for direct connection with 60° wire.

Litecraft Manufacturing Corp., 100 *Dayton Ave., Passaic, N. J.*



Outlets (3)

New 3-wire grounding outlets with short straps have been introduced. Available in 125-volt, parallel slots, or 250-volt, tandem slots, these outlets are designed for back and side wiring or for side wiring only. All contacts, including ground contact, are of bronze and grip both sides of cam blades securely. Each contact is fully enclosed in individual recess. Features include handy strip gauge on back of receptacle and green hexagonal grounding terminal at end of device.

Pass & Seymour, Solvay Station, Syracuse 9, *N. Y.*

Control (4)

A new Hi-Lo light-dimming control, No. 655, fits into a standard gem box. It will replace any standard single-pole light switch in seconds, using the same two wires to connect. Device is for use with permanently installed incandescent fixtures up to 300 watts and offers two levels of illumination using ordinary single-filament lamp bulbs. It is UL listed and rated at 300 watts, 120 volts ac.

Leviton Manufacturing Co., Inc., Brooklyn 22, *N. Y.*

Floor Box (5)

A new floor box line is designed for concrete floors. Boxes have 13 knockouts, including eight in-line, in a variety of sizes to cover conduit range from ½ to 1¼ in. They are $4\frac{11}{16}$ in. square. A minimum box height of 2⅛ in. is available which makes it suitable for shallow floors. Made of steel with bronze face plates, box is designed to accept a wide variety of standard receptacles to match any plug-in requirement. Brochure F9-132 is available.

Thomas & Betts Co., 36 *Butler St., Elizabeth, N. J.*

Instrument (6)

This new distribution transformer load indicator is a demand ammeter with a 30-minute lag. Indicator has an indicating pointer which follows current changes, and a red maximum reset pointer which indicates maximum value obtained since the last reset. Red pointer is reset by passing a magnet across face of glass cover of instrument. Instrument shown is rated at 20 amps full scale, which, based on about a 200% load, is intended for use on 25-kva distribution transformers having 2300-volt primary windings. Higher current ratings for heavier loaded primaries, and for use on secondary side, will also be available.

James G. Biddle Co., 1316 *Arch St., Philadelphia* 7, *Pa.*

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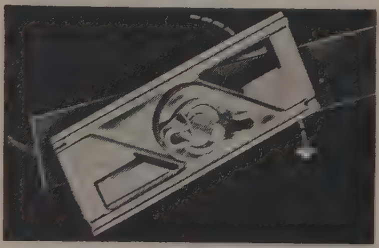
Troffers (7)

New troffers feature swing mounting brackets to simplify installation. New 4¾-in. shallow models come in 2- and 4-ft widths. Other units in ½-ft and 1-ft widths. are available. All units come in 2-, 4- and 8-ft lengths, are separately fused and include CBM/ETL ballasts. Swing-mounting brackets are preset for height of ceiling support members, SMB is released by tripping clip from inside troffer then hooked over support. Final adjustment to troffer is made by turning adjustment screws to draw up troffer trim flush with ceiling. UL listed.

Edwin F. Guth Company, 2615 *Washington Blvd., St. Louis* 3, *Mo.*



Hanger (8)

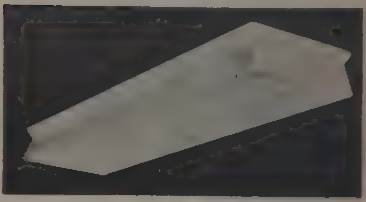
A new T-bar hanger, called "Tomic-Lock," is designed to simplify mounting of electrical fixtures to acoustical ceilings. It is constructed of spring steel, measures 1½ in. by 3½ in., and is designed for use on any standard T-bar. Hanger is fitted with a threaded stud and includes a heavy-duty wing nut and washer.

Tomic Sales and Engineering Co., 20000 *Sherwood, Detroit* 34, *Mich.*

Drill (9)

A new ¼-in. electric drill, known as the "Dirk," has been designed principally to give the operator better control of the tool; to make it possible to work in closer quarters; and to reduce operator fatigue. Motor is at a right angle to the drilling axis. Power from full 3-amp motor is transmitted by patented Spiroid gearing. Hand grip is large enough for operator to hold it with all four fingers and thumb. Trigger switch, which cannot be tripped accidentally, is controlled by index finger.

Disston Division, H. K. Porter Company, Inc., Pittsburgh, Pa.



Lighting Fixtures (10)

A new 86 Series of fluorescent lighting fixtures for use in classrooms and offices. Fixture affords 40° crosswise by 45° lengthwise cutoff, can be furnished for two 48-in. rapid-start lamps in 12-in. width or four lamps in 15-in. width, in 4- or 8-ft lengths. Standard fixture is for surface or pendant mounting, and can be furnished with top reflector for 100% downlighting. Its baffle-type louver hinges from either side, and fixture can also be relamped from top when pendant mounted. Catalog is available.

Neo-Ray Products, Inc., 315 *East* 22*nd St., New York* 10, *N. Y.*

Transformers (11)

A new lower and lighter oil-immersed line of Endur-All distribution transformers has been announced. They provide greater overload capabilities through larger cooling duct area, higher temperature insulation, and higher temperature oil. A locked core and coil assembly provides high short-circuit strength. Transformers have a high-gloss paint. Non-setting, reusable Buna-N gaskets are used throughout.

Allis-Chalmers Manufacturing Co., Milwaukee 1, *Wis.*

Jack Kenny Wins LOOK Contractor Award for residential wiring promotion

Uses Murray GUARANTEED FOR LIFE Sales Aids to Help Boost Rewiring Sales

Jack Kenny is being congratulated by Jack Catherwood of Long Island Lighting Co., Chairman of Residential Task Group, National Wiring Bureau and Al Palumbo, Long Island salesman for Murray Manufacturing Corp. on winning a LOOK award.

"For outstanding performance among electrical contractors in promoting residential wiring."

So reads the citation presented by LOOK magazine to Jack Kenny, President of K. J. Kenny, electrical contractors in Mineola, N. Y. Jack's promotional efforts to alert home owners to the need for adequate wiring to handle today's appliance loads paid off in increased sales.

The successful formula used by Jack Kenny was "Survey . . . Sell . . . and Satisfy." Find out which homes are still using low amp service; sell the homeowner through informative, hard-hitting direct mail and personal follow up; then satisfy him with a sound, high quality installation.

The "satisfier" used by Jack Kenny was Murray's guaranteed for life, MP fully magnetic circuit breakers. The Murray GFL Certificate presented to the homeowner, when the installation was completed, convinced him that he had made a wise decision . . . and a satisfied customer is still the best advertisement for an electrical contractor.

Murray promotional literature, particularly our popular consumer stuffer, played an important part in helping Jack Kenny sell adequate wiring to his many prospects.

Why not find out how you can cash in on the Murray Guaranteed for Life promotion program to build business, profits and prestige. See your Murray wholesaler today, or write directly to our GFL Merchandising Dep't.

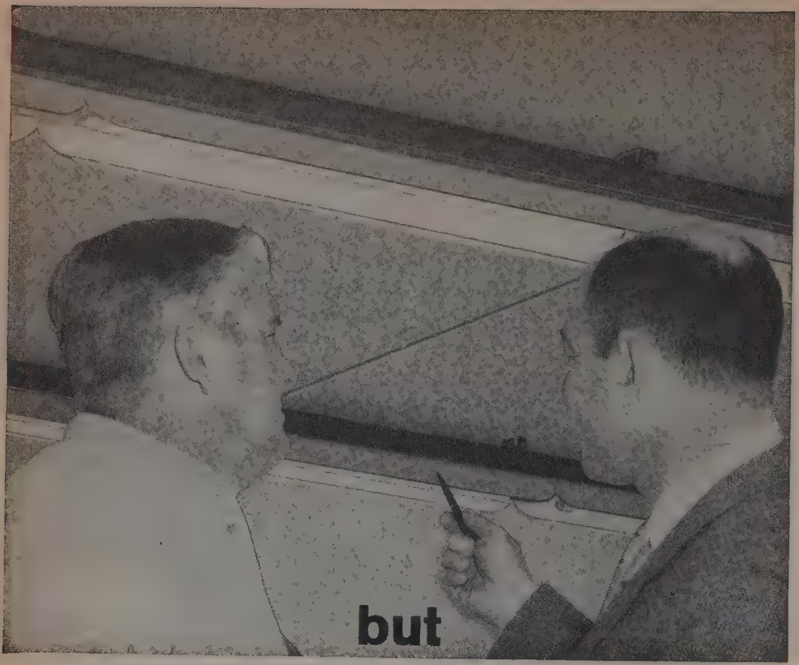
m Murray

MURRAY MANUFACTURING CORPORATION
1250 Atlantic Ave., Brooklyn 16, N.Y.

Survey: Dave Edwards makes periodic survey of homes with 30 amp service to build prospect list.

Sell: Frequent direct mailing of Murray GFL promotion material to prospective customers sells them on the benefits of adequate wiring.

Satisfy: Al Northup, right, is pleased with his new load center with Murray's "Guaranteed for Life" circuit breakers.



but what does it cost INSTALLED?

Anchoring to masonry, a big part of "in place" cost, includes at least three items: anchors, drills, labor. The cheapest anchor, if it isn't right for the job, may be the costliest to install.

For an economical, effective installation, help yourself to The Rawlplug Company's 40 years of experience designing, manufacturing, testing, and using anchors and drills for fastening just about every type of fixture to every type of masonry. Because we make a full line of masonry anchoring products, we can and will advise you impartially.

Our masonry anchoring know-how is summed up for you in an interesting eight-page booklet, "Install It for Less." For a free copy, ask your local Rawlplug branch or distributor, or use the handy coupon. Before you start to put that unit in place, see how you can anchor it to masonry for the lowest cost INSTALLED.

RAWL

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ANCHORING AND DRILLING
PRODUCTS FOR FASTENING
ANYTHING TO MASONRY

R-21

The RAWLPLUG Company, Inc.
212 Petersville Road, New Rochelle, N.Y.

Please send a FREE copy of "Install It for Less" to:

Name...

Title...

Company...

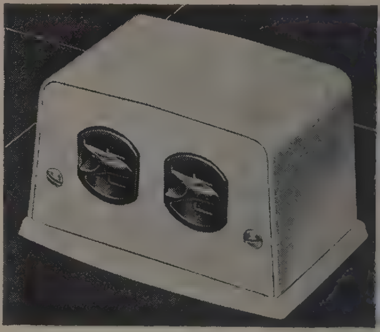
Address...

....

Cordless Drill (12)

A new cordless electric drill is powered by a self-contained energy source and a special motor. This drill completely eliminates the conventional cord and wall outlet power supply to a drill. Unit permits hole drilling anywhere—in high places, low places, out-of-the-way places—without any concern over an available outlet. The unit can drill 30,000 ½-in. holes in ¾-in. fir before its power cells have to be changed. It drills 75 ½-in. holes before the cells need to be recharged, and the cells can be recharged 400 times. Recharging is a simple matter with a companion charger made for this drill, permitting quick charge or slow charge (overnight or hooked up indefinitely).

Black & Decker, Towson 4, Md.



Fittings (13)

A new series of silhouette floor box service fittings, called "Lo-Boy," is designed especially to conform to the functional lines of modern commercial and institutional furnishings. They are less than 3 in. high when installed flush to the floor. The housing is made up of three aluminum die-castings, top shell, base and front plate. "Lo-Boy" fittings are available with grounded duplex receptacles on one side only, or on both sides. They are for 3-wire, 15-amp, 125-volt service. They are also available with 1-in. bushed openings on either one or both sides. Catalog pages are available.

Frank Adam Electric Co., Box 357, St. Louis 66, Mo.

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- OIL IMMERSED MOTOR STARTERS
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- MARINE CONTROL AC & DC
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- PILOT CIRCUIT DEVICES
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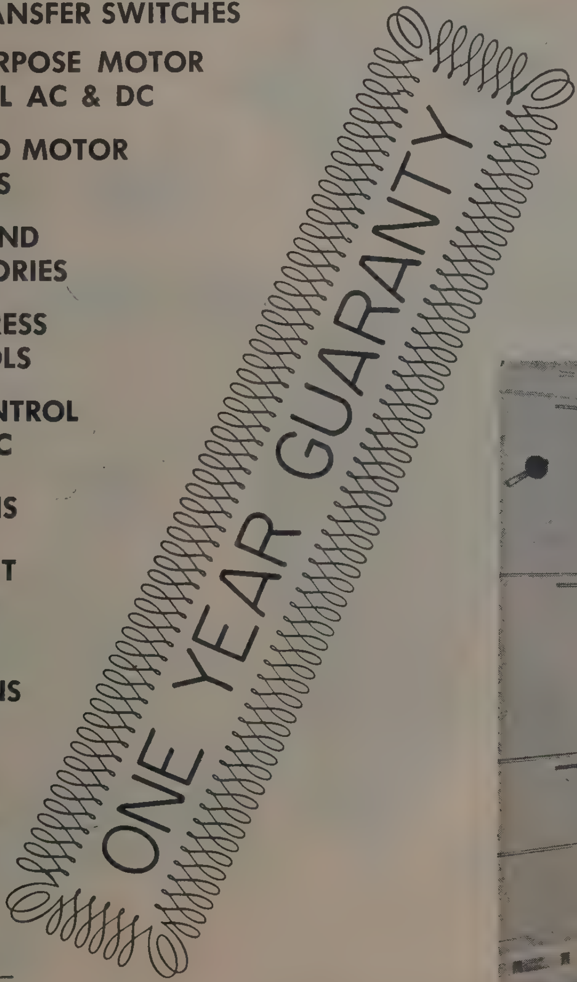

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FOR
ARCHITECTS
ENGINEERS
SPECIFICATION
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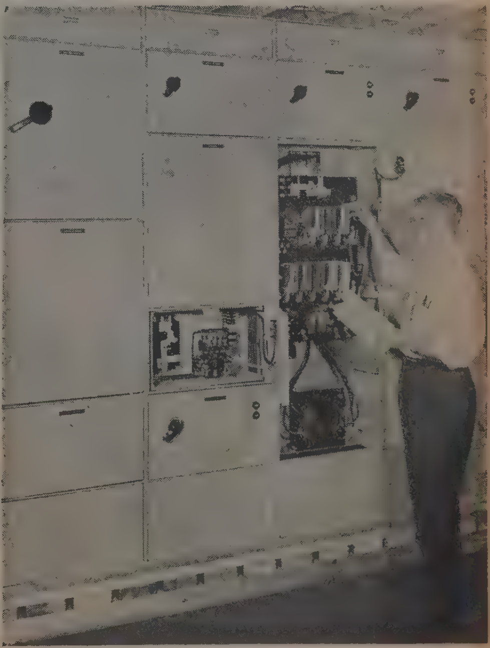
THE NEW
MONITROL HANDBOOK
FOR DESIGNING
CONTROL CENTERS



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Monitor

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TITLE__________ DEPT.__________

COMPANY____________________

ADDRESS____________________

CITY__________ZONE_____STATE_____

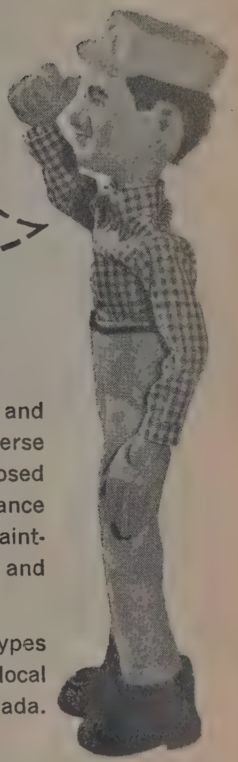
* KILLARK ENTRANCE ELBOWS

Shown above is 6″ size. Twelve other sizes down to ½″. Cast from copper-free aluminum in a variety of styles. Flanged cover overlaps gasket and edge of fitting making elbows waterproof. Sizes from 2″ up have cast aluminum cover. Service ells with weep holes and with grounding hubs for grounding rods can be furnished. Fast delivery from complete stocks

* KILLARK SERVICE ENTRANCE HEADS

Shown above is 6″ style. Complete line includes 30 sizes from ½″ to 6″ in threaded or slip-on styles. Copper-free aluminum castings will never rust, never stain building walls and are corrosion resistant. Special reversible feature allows use at end of horizontal conduit or at top of vertical conduit. Complete with high-quality composition insulator with number of holes required. Designed for easier handling of stiff, heavy cable Fast delivery from complete stocks.

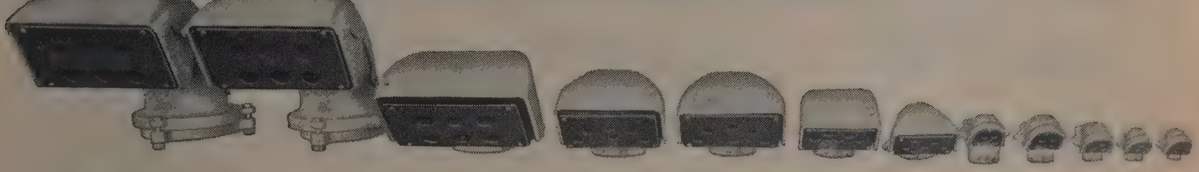
"Copper free aluminum construction gives Killark fittings bonus life"



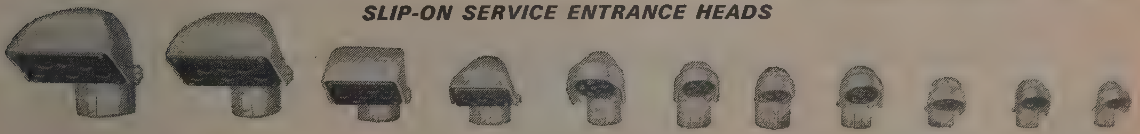
Because they are cast only from copper-free aluminum, Killark electrical fittings and fixtures provide dependable service for longer periods, particularly under adverse conditions. For example, they remain permanently rust-proof in weather-exposed locations and will never stain building exteriors. They also provide better resistance to various types of corrosion and can be used in many specialized applications. Painting and similar protective measures are never required. Specify Killark fittings and fixtures on your next job—and get the "bonus life" advantages of aluminum.

Killark entrance heads and entrance elbows, along with 7500 other sizes and types of fittings are carried in stock for immediate delivery . . . available from your local distributor or Killark warehouse stocks in 18 cities in the United States and Canada.

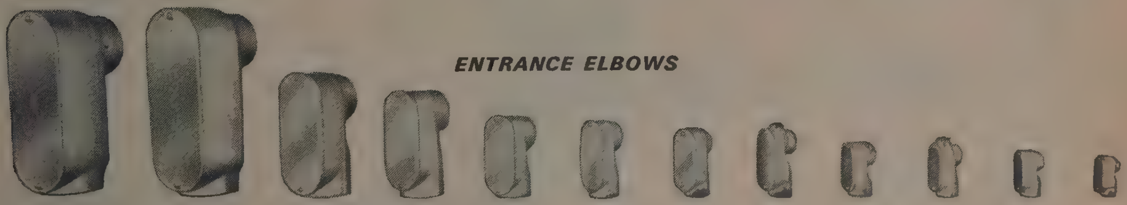
THREADED SERVICE ENTRANCE HEADS



SLIP-ON SERVICE ENTRANCE HEADS



ENTRANCE ELBOWS



Killark

Write for Killark Catalog

ELECTRIC MANUFACTURING COMPANY
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In Canada: Killark Electric of Canada, Ltd., 421 Islington Ave. South, Toronto 18, Ont. 6118

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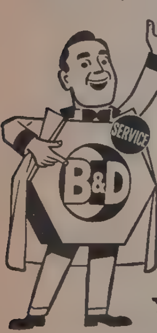
Only factory parts and factory-approved methods are used. Fast service and reasonable cost, always.



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FREE TOOL INSPECTION no cost, no obligation.

STANDARD B&D GUARANTEE after completion of all recommended repair work.

You'll find the location of the nearest B&D repair facility in the Yellow Pages under "Tools-Electric," or write for address to: THE BLACK & DECKER MFG. CO., Dept. 1207-S Towson 4, Md.

50th YEAR

See Tools Electric -Yellow Pages- for Service & Sales

Black & Decker

Quality Tool Service

Lighting Fixture (14)

A new line of decorative vapor-tight lighting fixtures is designed to protect architectural lighting installations from premature failures caused by rain, ice, sleet, corrosive fumes or non-explosive vapors and gases. Fixtures are satin finish with tapered opal diffusing globes and chrome-plated decorative guards. The complete line, in up to 200-watt sizes, includes one and two-light units for ceiling or custom pendant mounting, all die-cast in aluminum. All fixtures UL and CSA listed as fully enclosed and gasketed.

Stonco Electric Products Company, Kenilworth, N. J.

Switch Cover (15)

A new weatherproof switch cover provides full outdoor and industrial switch protection. Cover can be used with the Touchette switches or any touch type switch. Neoprene will repel live steam, extreme cold, grease, oil and hot water. Protection is offered for standard wall box or FS mounting.

Rodale Mfg. Co., Inc., 6th & Minor Sts., Emmaus, Pa.

Capacitors (16)

Ratings of industrial dustproof capacitors have been extended to 25 kvar from a previous high of 20. New units are available for 480- and 600-volt use, single or 3-phase. There is no corresponding increase in size, weight, or dimensions over the 20-kvar rating of the same voltage. Individual units provide corrective capacity near the load, when connected directly to machine terminals or at load centers. Units comply with all NEC requirements for low-voltage capacitors. Terminals, fuses and connections are accessible by removing cover, which is fastened by spring clips. Capacitors can be floor, wall, or ceiling mounted. When mounted in multiple assemblies, capacity can be changed by adding or subtracting units, or by substituting units of other ratings.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Interrupter Switch (17)

The Loadmaster 100, a 600-volt fused interrupter switch, is now available as an individually enclosed unit. Unit will be available in 800- and 1600-amp models. The unit is suited for heavy-duty industrial applications. Overload and fault protection are provided by Buss low-peak dual-element current-limiting fuses, which provide a close-in and interrupting rating of 100,000 rms symmetrical amperes. It will close-in on a faulted system having a capacity equal to its maximum rated interrupting capacity, without damage to its contact or operating mechanism. All models are electrically operated from a remote point. Protection against single-phasing is provided by an electrically actuated linkage.

Pennsylvania Transformer Div., McGraw-Edison Co., Box 330, Canonsburg, Pa.

Tool (18)

New Type "S" fuse-adapter remover is called "X-Tract-O" tool. The Type "S" fuse adapter removes or changes without damage to the Edison base of fuse holders, cutouts, panelboards, etc. It is a small self-contained tool. Bulletin No. 5 is available.

Trico Fuse Mfg. Co., 2948 N. 5th St., Milwaukee 12, Wis.

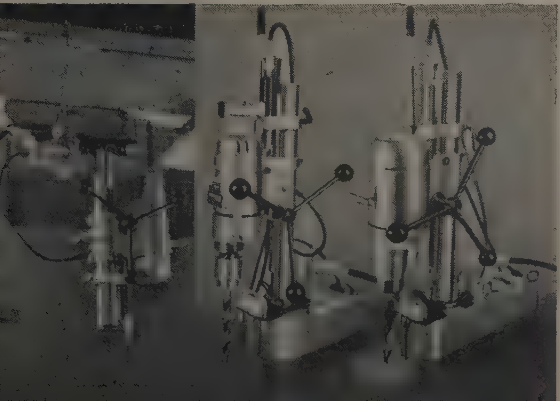
2 B&D Magnetic Drill Presses drill 1 hole every 29 seconds for 14 days!

ithout letup (or breakdown), making over 42,300 oles 15⁄16″ diameter in heavy steel plates . . . two lack & Decker Magnetic Drill Presses (¾″ and 4″ sizes) drilled around-the-clock for 14 days to eet an extraordinary deadline. The job resulted om a special rush order given Southern Reinforcing eel Company for prestressed concrete requiring large jigs. The need was for a tool with drill press curacy, portable drill versatility and time-proved durability. That's why the choice was the Black & Decker Magnetic Drill Press.

Over 1,500 pounds of magnetic power hold this drill in position . . . up, down *or* sideways. Famous B&D power makes any job quicker and easier. The Black & Decker Magnetic Drill Press is sold by leading distributors everywhere. *For sales and service, look in the Yellow Pages under* TOOLS ELECTRIC

emote Hydra-Power Feed available on all three &D Magnetic Drill esses. You just stand de and let these tools do e work — upside down, ht-side up or sideways.

Single-speed ¾″ and 1¼″ sizes, and two-speed 1¼″ model give you a three-way choice of B&D Magnetic Drill Presses. All operate manually or by remote control.



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CUTS MAN-HOURS TO MINUTES

THE BLACK & DECKER MFG. CO., Dept.1207
Towson 4, Md. (In Canada: Brockville, Ont.)

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☐ Please send additional information on..

Name..Title....................

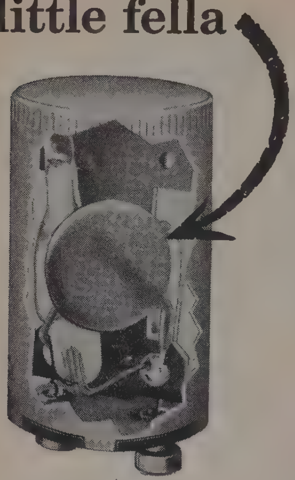
Company..

Address..

City..............................Zone.....State....................

☐ Impact Wrenches ☐ Hammers ☐ Belt Sanders ☐ Drills

This is the little fella



that cut starter failures by 98%

See it? That condenser up there isn't paper (the usual thing), but *ceramic.* It's in every Sylvania starter and the difference it makes in performance will surprise you.

A two-year test in one manufacturing plant showed Sylvania fluorescent starters had only 1 failure out of 340 starters. Conventional starters with paper condensers had 51 failures out of 330 starters.

Paper can't stand up as well to heat, cold, moisture. Ceramic condensers do. Another reason why Sylvania alone can give you an exclusive Certified Performance Policy *guaranteeing:* "If at any time, in your opinion, any Sylvania Fluorescent Starter fails to give satisfactory service during the 12 months from date of purchase, it may be returned to the supplier for full refund of purchase price."

Certified Performance Policy for...
FLUORESCENT STARTERS
Issued to
SYLVANIA

Yes, Sylvania lowers your TCL (Total Cost of Lighting). That means lower cost of lamp plus power plus MAINTENANCE. Try Sylvania next time you need starters!

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

Lighting Division, Sylvania Electric Products Inc.,
Dept. 15, 60 Boston St., Salem, Mass.
In Canada: Sylvania Electric (Canada) Ltd., Montreal.

Switches (19)

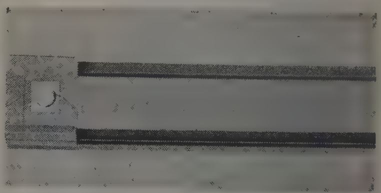
New flush mounting switches for switchboard or wall panels provide a wide variety of time-control functions for industrial or commercial applications. Both straight synchronous and synchronous carry-over models are available. The flush mounting case has a door which may be adapted for either right- or left-hand opening. It is supplied with a lock which may be installed by removing a knockout on the door.

Sangamo Electric Co., Springfield, Ill.

Power Centers (20)

Package power centers featuring rotary-handle circuit breakers in the secondary distribution section have been introduced. Rated up to 500 kva, the new line of indoor unit substations is available for primary voltages of 5 or 15 kv. Maximum over-all dimensions of units are 78 in. high, 98 in. long, and 42 in. deep. They are built around a unit enclosure which incorporates a primary disconnect, transformer, and secondary distribution sections. Rotary handle can be locked "on" or "off" and can accommodate up to three padlocks. Transformer sections, suitable for operation on 5- and 15-kv primary systems, are available in a wide range of sizes from 45 through 500 kva. They feature a 3-phase, 60-cycle, Class B dry-type transformer with four 2½% full-capacity taps. Class H insulation is also available.

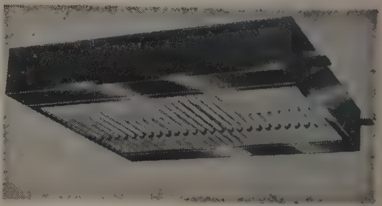
Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J.



Electric Baseboard (21)

A new electric baseboard designed for installation in homes, apartments, motels, churches, commercial and industrial buildings. Unit features a copper-aluminum heating element and a special patented fin design. Features include piano-hinged connection box with a lid-mounted thermostat, snap-on end caps, snap-on linear joints for "in-line" joining, and a piano-hinged inside corner which permits joining of baseboard sections at any angle. It also features a thermal safety cut-out which runs the length of the unit. Baseboard in lengths of 3, 4, 6 and 8 ft is available for both 120- and 240-volt hook-ups. Literature is available.

Sundial Electric Corp., 130-15 89th Road, Richmond Hill 18, N. Y.



Infrared Ovens (22)

New high-intensity infrared ovens and furnaces are now available. New techniques, using fluid cooling, now make possible very compact quartz-lamp ovens and furnaces with high heat-transfer rates. Other features are precision control with no contamination during processing. Almost any shape of equipment may be fabricated to meet nearly any requirement for high temperatures, up to 3000°F, or for short cycles. Literature is available.

Fostoria Corporation, Box 100, Fostoria, Ohio

that helps VHO fluorescent keep on giving more light

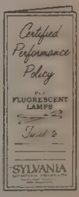
Only Sylvania VHO Powertubes give you the profile and the policy that guarantee more light – or your money back!

Within a year dust can black out *20% or more* of the light you pay for. That's why Sylvania VHO (Very High Output) Powertubes are made round and smooth. Their simple tubular design sheds dust, and wipes clean with just a stroke.

But even more, it's the superior combination of new Sylvania phosphors and gases *inside* that enables this tube–only 1½" in diameter – to deliver the brightest light of all Sylvania fluorescents.

Because they're of the familiar standard weight, no oversize fixtures are needed for VHO Powertubes. And you get 2½ times more light than from standard fluorescents!

No wonder Sylvania can offer this *exclusive* money-back guarantee: If at any time a Sylvania Fluorescent Lamp fails in your opinion to provide better performance than any other brand fluorescent lamps, on the basis of uniformity of performance, uniformity of appearance, maintained brightness and life, it may be returned to the supplier for full refund of purchase price.



Get the straight story on light. Call your Sylvania representative. Or write: Lighting Division, Sylvania Electric Products Inc., Dept. 157 60 Boston St., Salem, Mass. In Canada: Sylvania Electric (Canada) Ltd., Montreal.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Current news reports

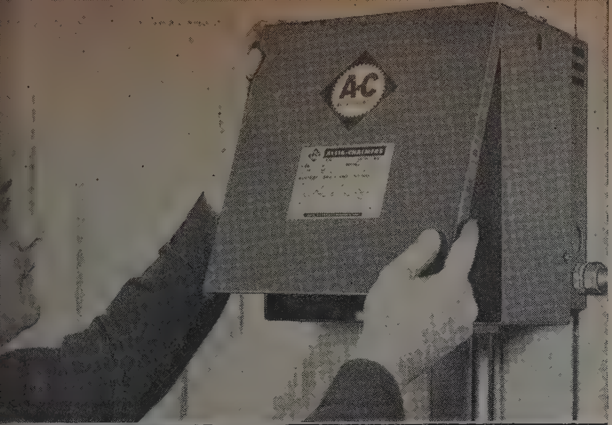
WHAT'S HAPPENING IN ELECTRICAL SERVICES?

Highlights: A dry-type transformer that cuts installing time from 90 to 40 minutes. A motor control center that saves space. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your nearby Allis-Chalmers office for details or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

Lowest height, easiest access 5-kv metal-clad switchgear on the market. Just 72 inches high, you get eye-level instrumentation, shoulder-height accessibility of component parts. Other outstanding advantages: front-accessible current transformers; maximum compartmentation and dead-front construction for greater safety; full-panel metering; rapid, one-stroke breaker insertion. Choice of Allis-Chalmers stored energy or solenoid operated circuit breakers.

Low cost answer to an outdated electrical system: An Allis-Chalmers unit substation. It distributes full power at the center of the load. Voltage drop and conductor losses are minimized . . . secondary wire to machines is shorter and less expensive. And there's no space problem! Mount an Allis-Chalmers unit substation anywhere, in a corner of the production floor, on balconies, in the basement. Metal enclosures eliminate need for vaults — and provide attractive appearance.

Curvacore, Super-Seal, Poxeal and Chlorextol are Allis-Chalmers trademarks.



Cut installing time in half with new, whisper-quiet dry-type transformers! Now 35% smaller, lighter, this new design eliminates common installation problems. Unique 3-piece case makes handling, wiring go like clockwork. You'll install them in 40 minutes instead of the usual 90 minutes. Every known factor in subduing noise has been incorporated . . . and exclusive *Curvacore* construction lowers exciting current, core losses. Requires *no* special insulating cable for hookup.

Control centers cut costs . . . You save space, simplify wiring and reduce inspection and maintenance expenses with new A-C low-voltage motor control centers. Plug-in terminal blocks and draw-out construction cut inspection and maintenance time by making it quick and easy to withdraw or remove control units. Pushbuttons and pilot lights on removable frames eliminate failures common with hinged wiring. Special connectors make it impossible for bus connections to loosen.

Acid drips, but open motor's efficiency never drops: This *Super-Seal* open motor replaced a TEFC unit driving a pump in a vanadium and uranium extracting process. Though constantly subjected to drippage of a sulphuric acid and organic phosphate mixture, it keeps right on running. Its *Poxeal* insulation defies corrosives, moisture and contaminants. Open design gives a service factor of 1.15 . . . provides reserve capacity to meet sudden overloads.

Lower first cost is just one of many advantages of this packaged unit substation. Simplified engineering, planning and purchasing reduce installation and maintenance costs. These A-C units provide reduced power losses, better regulation and flexibility for expansion. Factory-assembled, wired and tested to meet all standards. Transformer types available to fit your needs include oil-filled, *Chlorextol* liquid-filled, dry-type and sealed dry-type units.

ALLIS-CHALMERS

A-1478

...a ROYAL "POWR-KORD" for every job!
ROYAL
INDOOR
OUTDOOR
for TOOLS... APPLIANCES... EQUIPMENT
ROYAL

The *right* extension cord is essential for safe, dependable operation of on-the-job equipment and temporary lighting . . . the *right* size to carry the load, the *right* length to supply the power without voltage drop. That's why there's a Royal heavy-duty POWR-KORD to fit *every* job. Available in one quality (the very best) . . . two types (rubber and vinyl) . . . three colors (red, black, yellow) . . . four wire sizes (12, 14, 16, 18) . . . and over five handy cord lengths (10 to 100 ft.). See your wholesaler. He has the facts — and Royal POWR-KORDS in stock, ready for your work.

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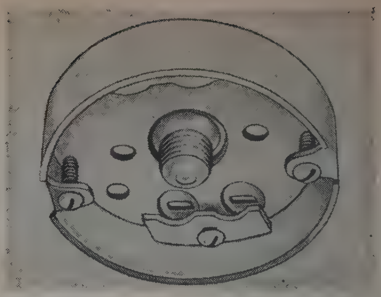
...an associate of ITT

ROYAL ELECTRIC CORPORATION
PAWTUCKET, RHODE ISLAND
In Canada:
Royal Electric Company (Quebec) Ltd., Pointe Claire, Quebec



Ceiling Box **(23)**

A revision has been made in this shallow ceiling box, known as a pancake box. A new clamp-screw design now passes through the bottom of the box, allowing easier handling and faster adjusting time. It is adaptable for new and remodeling work. Specifications are: 3¼-in. diameter; available in ½-in. or ¾-in. depths; available with ½-in. knockouts in bottom or with stud; furnished with or without clamps; clamps available for either non-metallic or armored cable.

Arrolet Corp., Montgomery, Pa.

Cable Suspension System **(24)**

New Line-Flex cable suspension system is now available. It is designed to be used in non-supported rigid lengths of up to 14 ft or catenary applications involving lengths of 400 or more feet. Line-Flex may be entirely dismantled at any time for re-use as required. It is available in zinc coated or stainless steel and in several diameters. It can be supplied in coils or in standard lengths. Available as complementary accessories are "Line-Fit" end-to-end and box terminal connectors; "Line-Strut" suspension clamps and supports; and "Line-Pull" manual cable-pullers.

Perfect-Line Mfg. Corp., Hicksville, L. I., N. Y.

Switches **(25)**

Complete line of 20-amp ac switches has been announced. Quiet in operation with binding screw terminals or with pressure terminals, they are available in strap type and Despard interchangeable types. All have shallow, totally enclosed bodies, which allow ample wiring room in box. Positive control of contact arm in both directions is provided. Available in single pole, double pole, 3- and 4-way. Literature is available.

Pass & Seymour, Inc., Solvay Station, Syracuse 9, N. Y.

YOU CUT SOCKET COSTS UP TO 50% WITH GENERAL ELECTRIC'S NEW 200-AMP RINGLESS DESIGN WITH NEW MANUAL BY-PASS

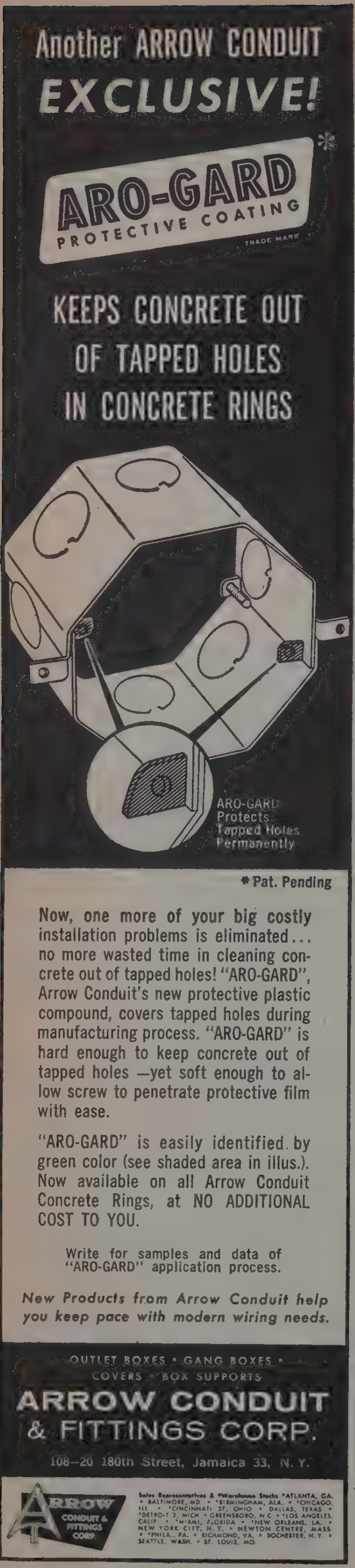
General Electric's new 200-amp ringless design offers you today's best socket buy. Consider cost. New SI-60 is priced as much as 50% less than any other fully-rated 200-amp socket. Consider advanced design. Operation of G-E's new, exclusive screw-operated manual by-pass is fast, simple...requires no special tools, jumpers or clips, just a screwdriver . . . self-contained, positive action. Unique terminal block assembly—with one-piece combination jaw and connector strap—offers greater reliability through low heat rise. And consider versatility. To increase application, help cut stock costs, G-E's new SI-60 socket fully meets industry requirements for aluminum or copper wire. For complete information contact your G-E Sales Office or Authorized Distributor. Or, write General Electric Company, Somersworth, New Hampshire.

711-03

NEW, EXCLUSIVE G-E MANUAL BY-PASS is self-contained on terminal block; provides fast, positive make or break action, requires only a screwdriver...no special tools, jumpers or clips. Socket cover can not be closed unless by-pass is open.

NEW G-E 200-AMP SI-60 RINGLESS SOCKETS now provide quality meter protection at low cost.

GENERAL ELECTRIC



Another ARROW CONDUIT
EXCLUSIVE!

ARO-GARD*
PROTECTIVE COATING
TRADE MARK

KEEPS CONCRETE OUT
OF TAPPED HOLES
IN CONCRETE RINGS

ARO-GARD
Protects
Tapped Holes
Permanently

*Pat. Pending

Now, one more of your big costly installation problems is eliminated... no more wasted time in cleaning concrete out of tapped holes! "ARO-GARD", Arrow Conduit's new protective plastic compound, covers tapped holes during manufacturing process. "ARO-GARD" is hard enough to keep concrete out of tapped holes—yet soft enough to allow screw to penetrate protective film with ease.

"ARO-GARD" is easily identified by green color (see shaded area in illus.). Now available on all Arrow Conduit Concrete Rings, at NO ADDITIONAL COST TO YOU.

Write for samples and data of "ARO-GARD" application process.

New Products from Arrow Conduit help you keep pace with modern wiring needs.

OUTLET BOXES • GANG BOXES • COVERS • BOX SUPPORTS

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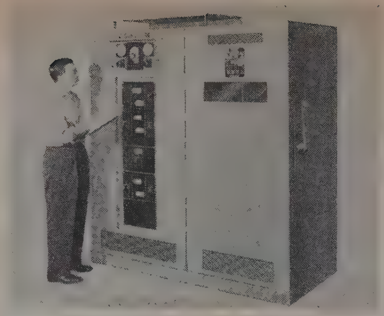
108–20 180th Street, Jamaica 33, N. Y.

ARROW CONDUIT & FITTINGS CORP.

Sales Representatives & *Warehouse Stocks *ATLANTA, GA. • BALTIMORE, MD • *BIRMINGHAM, ALA. • *CHICAGO, ILL • *CINCINNATI 37, OHIO • DALLAS, TEXAS • *DETROIT 7, MICH • GREENSBORO, N C • *LOS ANGELES, CALIF • *MIAMI, FLORIDA • *NEW ORLEANS, LA. • NEW YORK CITY, N. Y. • NEWTON CENTRE, MASS • *PHILA., PA. • RICHMOND, VA. • ROCHESTER, N.Y. • SEATTLE, WASH. • ST. LOUIS, MO.



Substations (26)

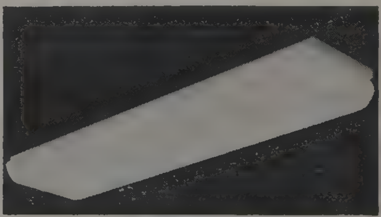
New Power-Zone package unit substation combines compact size and easy handling with capacities from 75 to 500 3-phase kva, with primary voltages up to 4800 volts and secondary voltages up to 600 volts. A forced-air cooling system with high-temperature alarm is available to increase kva capacity by one-third. Versatile construction permits use of many types of components. Bulletin SD-137 is available.

Square D Company, Mercer Road, Lexington, Ky.

Switch (27)

A new high-voltage load interrupter switch for metalclad switchgear in industrial and commercial buildings has been introduced. The new 3-pole load interrupter switches up to 1200 amps, closes on 60,000 amps when fused. Switch meets all NEC requirements for fault closing. They use parallel pairs of blades, have dual contacts, and include integral quick-make, quick-break mechanism. Nominal voltage ratings are 4.8, 13.8 and 14.4 kv with a continuous and interrupting rating 1200 amps.

S&C Electric Company, 4435 *North Ravenswood, Chicago* 40, *Ill.*



Fluorescent Luminaire (28)

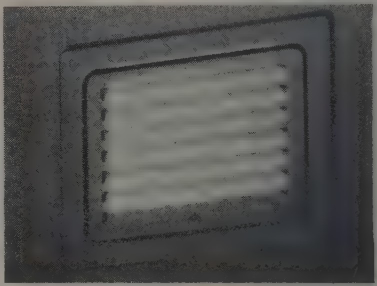
A new fluorescent luminaire, called White Cloud, has an all plastic "wrap-around" type of diffuser. It is designed for use in schools, stores, offices, institutions and other large lighting areas. Overall dimensions are 12 ft wide by 49 ft long with 3¾ ft surface-mounted depth or 2⅞ ft semi-recessed depth from ceiling. The one-piece diffuser is white polystyrene. Sides, ends and face are completely luminous. Two vinyl hinges hold diffuser suspended from one side for relamping or cleaning. For continuous row installation channel ends are butted together.

Solar Light Manufacturing Co., 400 *North Ashland Ave., Chicago* 22, *Ill.*

Transformers (29)

A completely new line of Class H dry-type transformers offering reduced size, weight, and audible sound levels has been developed. Included in line are six major types of standard single- and 3-phase transformers rated from 600 volts HV and below through 15,000 HV and from 3 kva through 2000 kva. Improved design and operating characteristics make them especially suitable for installation indoors in plants, schools, hospitals, and office buildings. Terminals on new units are suitable for aluminum or copper connections, and are located in bottom of transformer. Bulletin 162 is available.

Niagara Transformer Corp., P. O. Box 23, *Buffalo* 25, *N. Y.*

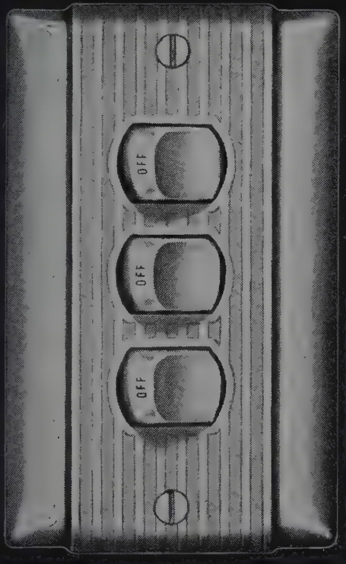


Night Light (30)

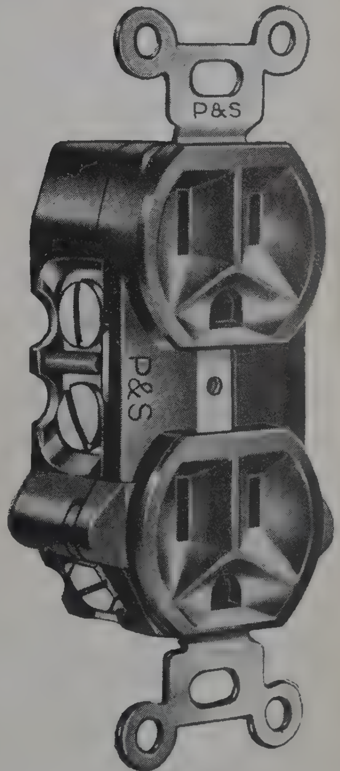
A new night light using a small fluorescent lamp, called fluorescent nite light, when used an average of ten straight hours a day, will light up to 21 months, 6,000 hours, before the standard 4-watt, 6-in. fluorescent lamp needs to be replaced. Unit has a louvered face and is recessed into the wall. For use in commercial, industrial and institutional establishments, it is also suitable for homes and apartments. Wired for 120-volt service, the outside frame dimensions are 8¼ by $6\frac{7}{16}$ in. Dimensions of recessed box are 7 by $5\frac{5}{16}$ by 3 in. Listed by UL.

Day-Brite Lighting, Inc., 6260 *N. Broadway, St. Louis* 15, *Mo.*

P&S means ROCKER-GLO



and 3-WIRE GROUNDING too! . . .



5262

It takes skill and precision to manufacture a switch that has earned the high reputation of Rocker-Glo. This same skill and precision builds the same high standards into *3-Wire Grounding* devices. For heavy duty devices or residential, the P&S trademark is your assurance of top quality, best value in *every kind* of wiring device.

PERFORMANCE SPECIFIED

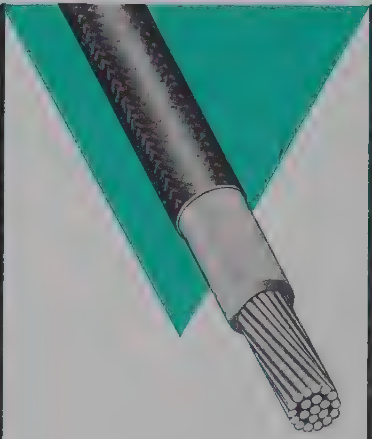
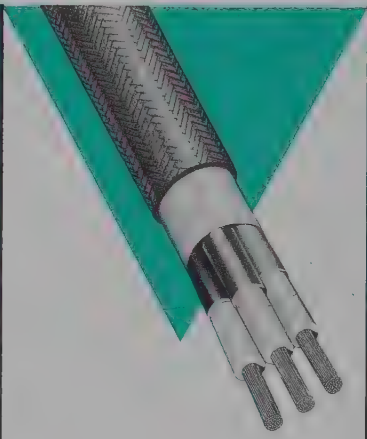
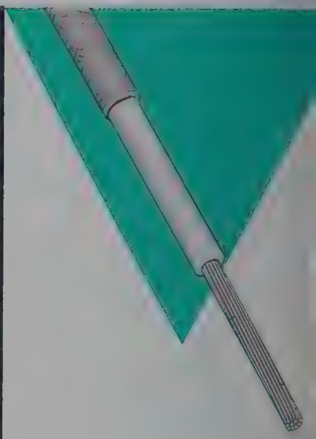
For information on 3-Wire Grounding

write Dept. ECM 761

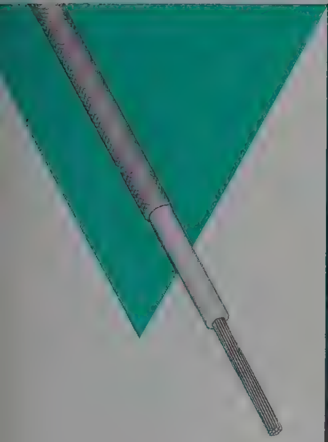
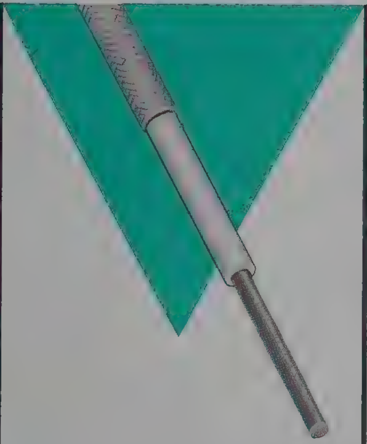
P&S ® PASS & SEYMOUR, INC.
SYRACUSE 9, NEW YORK

60 E. 42nd St., New York 17, N.Y. 1440 N. Pulaski Rd., Chicago 51, Ill. In Canada: Renfrew Electric Co., Ltd., Toronto, Ontario

Rockbestos Silicone Rubber

	 POWER CABLE	 CONTROL CABLE	 APPLIANCE and FIXTURE WIRE
Voltage	600 and 5000 volts	600 volt	300 and 600 volt
Operating Temperature	125°C	125°C	150° and 200°C
Size Range	600V: #14 AWG to 500,000 CM 5000V: #8 AWG to 500,000 CM	#14 — #9 AWG	150°C: #22 to #18 AWG — 300 volt #22 to #10 AWG — 600 volt 200°C: #18 to #12 AWG — 600 volt
Construction	**Conductor** — Tinned copper, stranded **Insulation** — Silicone rubber **Covering** — Asbestos braid	**Conductor** — Tinned copper, stranded **Insulation** — 3/64ths silicone rubber, glass braid, color coded **Covering** — Cable tape, asbestos braid. Also available in galvanized steel, aluminum or bronze interlocked armor	**Conductor** — Tinned or nickel plated, stranded or solid **Insulation** — Silicone rubber **Covering** — Glass braid
Applications	Power wiring in high ambient temperature locations. Allows the most efficient utilization of the conductor. Satisfactory for installations in wet or dry locations.	Recommended where control or signal circuits are exposed to high ambient operating temperatures . . . steel mills, power stations, automotive, cement and glass plants.	For wiring of high wattage units, such as lighting fixtures, clothes dryers, sun lamps, stoves, electronic equipment, water heaters, ovens, and other apparatus.

Wire & Cable Selector

	
APPARATUS and MOTOR LEAD WIRE	**LIGHTING WIRE**
600 volt	600 volts
200°C	125°C
#20 to 4/0 AWG	#14 to #8 AWG
Conductor — Tinned copper, stranded **Insulation** — Silicone rubber **Covering** — Glass braid	**Conductor** — Solid tinned copper **Insulation** — Silicone rubber **Covering** — Glass braid
For leads to motors and transformers in high temperature locations. Stands up excellently under varnish dip and bake processes.	For lighting circuits in high ambient temperature locations.

Rockbestos Silicone rubber cables give you these outstanding advantages:

- excellent heat resistance 125°C-200°C allowable conductor temperature
- flame resistant—slowly forms non-conducting ash maintaining circuit integrity
- corona and ozone resistant
- maintains flexibility from —130°F to +500°F
- excellent resistance to oil, solvents, fuels and chemicals
- excellent electrical properties

ROCKBESTOS WIRE AND CABLE CO.
division of CERRO CORPORATION
Nicoll and Canner Sts., New Haven, Conn.

Gentlemen:

I would like to know more about the unique advantages of Rockbestos Silicone Rubber Wire and Cable. Please send me the following:

☐ The Rockbestos Silicone Wire & Cable Catalog.
☐ A sample of your silicone rubber wire.
☐ Please have distributor or salesman call.

Name ____________________

Company ____________________

Address ____________________

year after year...

all the guarantee you need:

ballasts with confidence built in!

SOLA'S business was founded on ballasts. And, through its pioneering in the fluorescent field, SOLA has evolved many design advantages that pay-off in record performance. Features like "constant wattage," "Sequenstart," and, "upside-down construction," to reduce ballast temperature. Records of SOLA fluorescent ballast replacements actually prove that *only 1.4 per thousand ever fail within warranty!*

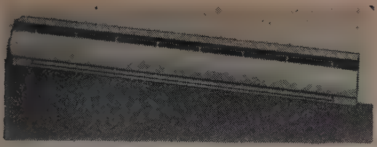
Since you pay no premium price for SOLA's premium reliability, there's no simpler choice for minimizing ballast "blackouts" — building customer goodwill. Specify *SOLA* every time.

SOLA ballasts are available for a wide range of lamps and applications. Write or phone us now for details on these CBM certified units — all built to guarantee you full light output, throughout full rated life.

SOLA
DIVISION OF
BASIC PRODUCTS CORPORATION

B P
C

SOLA ELECTRIC CO.
Busse Road at Lunt,
Elk Grove Village, Ill.
HEmpstead 9-2800
IN CANADA, Sola-Basic
Products Ltd., 377 Evans
Ave., Toronto 18, Ontario



Electric Baseboard (31)

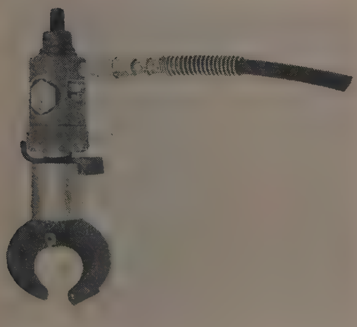
An all new Chromalox residential electric baseboard heater is offered in 3- and 4-ft lengths. When installed they are 6 in. high and 2½ in. deep. The Chromalox wrapped-fin heating element floats freely behind a full length specially designed baffle. A built-in thermal cut-out provides positive protection against overheating if heater is accidentally covered. Each unit can be mounted without removing front cover by means of elongated screw slots that provide adjustment to meet wall studs. A resilient vinyl strip along back top edge prevents any gap due to uneven wall surface. Various models have heat outputs ranging from 500 to 1000 watts. Voltages range from 120 through 277. A built-in thermostat is optional.

Edwin L. Wiegand Company, 7500 *Thomas Blvd., Pittsburgh* 8, *Pa.*

Fluorescent Lamp (34)

The "Premium 3" 40-watt fluorescent lamp is now produced in three new colors—deluxe cool white, deluxe warm white and daylight. They supplement the three previously announced colors—cool white, warm white and white. It can be used in either "preheat" or "rapid start" circuits.

General Electric Co., Nela Park, Cleveland 12, *Ohio*



Cable Cutter (33)

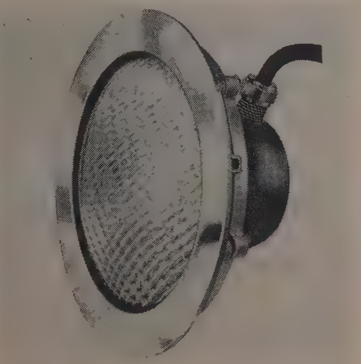
A new hydraulic cable cutter, available as a knockout set attachment or complete cutter set, will shear aluminum or copper cable. A feature is the cutter-closer, which mechanically closes blades after cable insertion. In attachment form, it fits most hydraulic knockout sets, as is. With the addition of a pull rod, it can be used with any RC-112 or RC-426. As a complete set, cutter includes cutting assembly, hydraulic pump, hose and ram with carrying box.

Blackhawk Industrial Products Co., Butler, Wis.

Connector (34)

A new grounding connector, called the "Hamron," was designed to give the advantages of a compression connector without the disadvantage of compression tools. Features include positive connection, permanent spring compression and easy breathing. Type DH driving heads, made of hardened steel, are recommended for installation of the Hamron connector.

Anderson Electric Corp., Leeds, Ala.



Lighting Unit (35)

A new Slim-Lite "12" and new Para-Bulb are now available. The Slim-Lite "12," a completely new 12-volt, 300-watt sealed beam lamp, 4 in. in depth, was developed to meet the need for an underwater light operating on low voltage. The combination of filament, reflector and lens gives a scientifically designed illumination pattern ideal for pool use. Para-Bulb, a 12-volt, 300-watt bulb, is made with the same glass envelope and base as the 110-volt, 400-watt bulb prevalent in pools today, and can be used, for easy conversion of existing 400-watt lights to 12-volt operation. A grounded metallic shield separates the 110-volt winding from the 12-winding. Fuses are arranged so that there is a replaceable fuse on the 12-volt side and a factory-sealed fuse on the 110-volt side. Transformers are UL listed.

Paragon Swimming Pool Co., 98 *Murray Ave., Larchmont, N. Y.*

EXTRA VALUE* FASTENERS

Red Seal®
CALKING ANCHORS

*EXCLUSIVE RED FIBRE DISC KEEPS DIRT OUT OF THREADS.

KEYSTONE® EXPANSION SHIELDS
*Exclusive Nutstop Prevents Nut Pullout.

DHD® HAMMER DRIVE ANCHORS
*Exclusive Internal Ribs Provide Maximum Expansion.

DIAMOND-P-® LAG SCREW SHIELDS
*Exclusive 4-Directional Expansion Fits Irregular Holes.

wing-it HOLLOW WALL ANCHORS
*5 Times Greater Thread Area... No Stripping!

DIAMOND SPRING TOGGLE BOLTS
*Patented Feature: Wings Form Truss; Don't Bear on Bolt.

PLUS
More Than 500 Other Items With "Built-In" Extras
PLUS
Exclusive Pole Line Hardware

FREE SAMPLES
and Pocket Guide to Better Fastening
Send Request to:

DIAMOND
DIAMOND EXPANSION BOLT CO., INC.
506 North Avenue, Garwood, N. J.

Fasteners With Extra Value

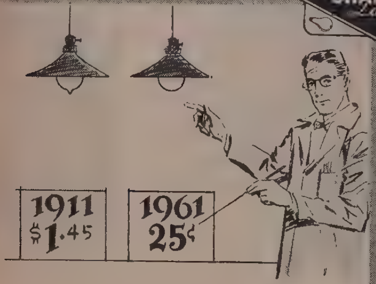
Facts of Light!

4, 9, 16, 25, 36
THE ARITHMETIC OF LIGHTING

The light you receive from a lamp varies inversely as the square of the distance you are from it. If you are 4 feet from a lamp and move away to 12 feet, you will receive only 1/9 the previous light.

RECOMMENDED ILLUMINATION LEVELS FOR RESEARCH FACILITIES

Seeing Task	Footcandles
Detail drafting, fine detailed model design	200
Instrument readings	100
Rough layout drafting, auditing, tabulating machine operation, calculating	150
Lab test set-up area (where exact quantities are measured)	100
Model set-up area, intermittent reading, intermittent filing	70



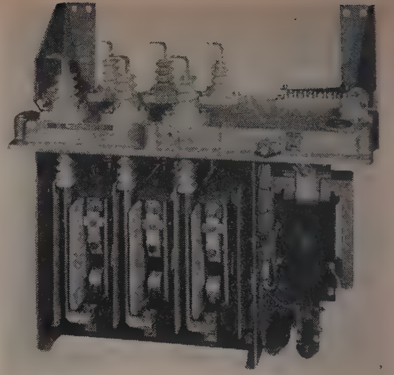
LIGHT BULBS ARE A BARGAIN

50 years ago a 100 watt bulb cost $1.45. In fact, if 1910 production methods attempted to supply today's demand, a 100 watt bulb would cost about $4.10. Today, you can buy a much better 100 watt bulb for 25 cents list.

OVER 200 INSPECTIONS GUARD CHAMPION LAMP QUALITY.

Your Best Buy in Lamps

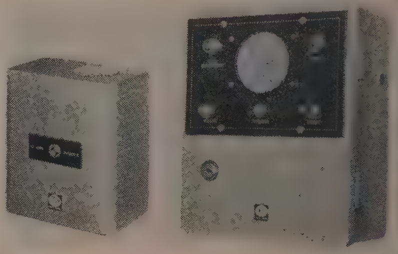
CHAMPION LAMP WORKS, Lynn, Massachusetts
CHAMPION INCANDESCENT-FLUORESCENT



Contactor (36)

A new oil-immersed contactor, Type K, for starting and controlling ac motors on 2300- and 4800-volt power systems. This 3-pole contactor has a continuous current-carrying capacity of 400 amps and interrupting capacity of 50,000 kva. Contact assemblies, which operate submerged in oil, employ magnetic blowouts and single-break contacts. Copper-tungsten contact surfaces are close to tank bottom and arranged so that arc movement, during interruption, is horizontal through the oil.

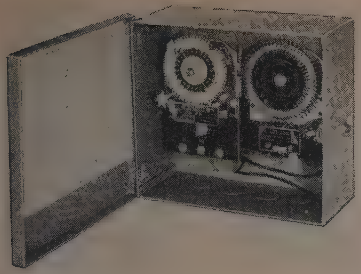
Westinghouse Electric Corp., P. O. Box 2099, *Pittsburgh* 30, *Pa.*



Alarm System (37)

A new type of audio alarm system provides tamper-proof security for commercial, industrial and institutional buildings during periods of non-occupancy. Signal units with microphones, which are ultra sensitive to sound and vibration, detect unauthorized entry through doors, windows, walls or ceilings. A signal unit will detect presence of any intruder, even if that person had remained in hiding after a normal occupancy period. Without any indication to alert the intruder, an alarm is instantly relayed to a monitor unit which can be located as far as five miles away. A built-in emergency power supply will operate the system in the event of regular power interruption.

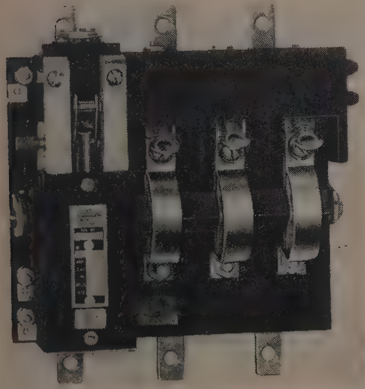
Powers Regulator Company, 3400 *Oakton St., Skokie, Ill.*



Signal Timer (38)

A new clocklike device, called "Municipal" signal timer, is designed to sound sirens or whistles, automatically. It operates the town curfew or time whistles at the exact time desired each day. Signals may also be coded, for it will sound more than one signal each time, or a combination of long and short blasts may be scheduled. Signal duration as well as spacing between whistles is adjustable in one second increments, from 1 to 55 seconds. Signals will sound only on the hour but can be set for any or all hours of the day or night. Unit has a built-in Skip-A-Day omitting device.

Tork Time Controls, Inc., Mt. Vernon, N. Y.



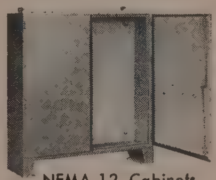
Contactors (39)

A new MPH series of electrical contactors especially designed for quiet operation is now available. Mechanically held in either open or closed position. Low inrush currents are a feature. Contactors are equipped with extended bus bars for installation in panels and switchboards. All parts are accessible for inspection and maintenance convenience. They are available in 30-, 75- and 100-amp sizes and are rated up to 600 volts ac line-voltage non-inductive loads, maximum lighting loads of 277 volts. Bulletin B-15 is available.

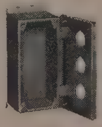
Zenith Electric Co., 152 West Walton St., Chicago 10, Ill.

the fastest label from coast-to-coast

Whenever you order *any* one of Keystone's quality wiring installation products . . . you can be sure of seeing it on your doorstep . . . *fast!* Complete stocks of Wireways, Fittings, Boxes, Cabinets and Enclosures are ready and waiting at Keystone warehouses from coast-to-coast to make sure there's *no* delay from order to delivery. You can always depend on the welcome sight of prompt Keystone service . . . *wherever you are.*

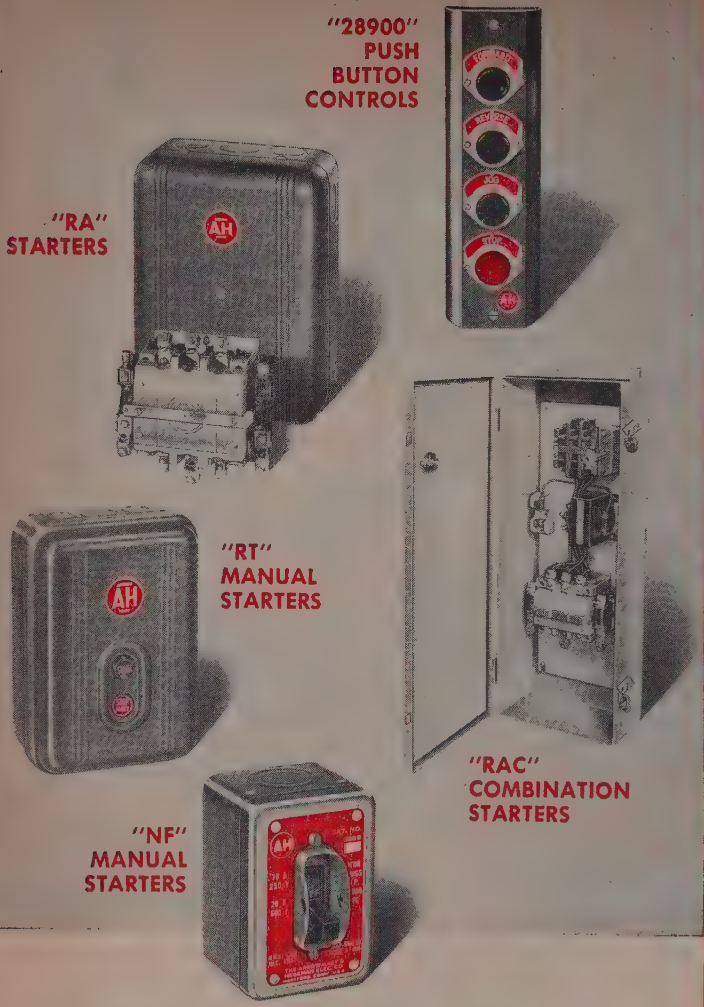

NEMA 12 Cabinets

Switch Boxes


Pushbutton Enclosures

Outlet Boxes

KEYSTONE
MANUFACTURING COMPANY
DIVISION OF AVIS INDUSTRIAL CORPORATION
23330 Sherwood Ave. • Warren, Michigan



WHEN LOOKING FOR GOOD PRODUCTS . . .

LOOK FOR A GOOD NAME

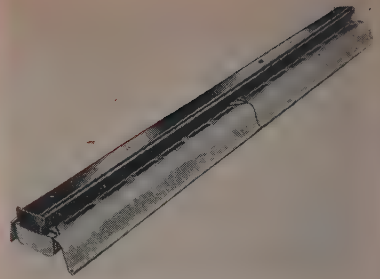
The motor controls shown above, and all the other products in the *complete* ARROW-HART motor control line, bear a name that has earned a high rating in the electrical industry during the past 67 years. This fine name — ARROW-HART — is your assurance of motor controls you can rely on for quality and dependability.

Outstanding service—on-the-job assistance for maintenance personnel and plant engineers—is another reason for ARROW-HART's fine reputation. This combination of a *complete* line, a superior product *and* superior service makes ARROW-HART motor controls your *logical* choice . . . so ask your distributor for ARROW-HART.

ARROW AH HART
Quality since 1890

MOTOR CONTROLS • ENCLOSED SWITCHES
APPLIANCE SWITCHES • WIRING DEVICES

ARROW AH HART



Fluorescent Fixture (40)

A new fluorescent fixture design features an air space, provided by an embossment in the end, which separates the channel from the reflector. Cool air circulating freely through this space ventilates the entire fixture so that both tubes and ballasts operate at lower temperature. The J-Line fixtures are offered in a complete range, for all industrial and wide area lighting applications.

Wheeler Reflector Co., Hanson, Mass.

Floodlights (41)

New cantilever floodlights are fabricated of structural and cast alloy aluminum. Clear Plexiglas shields are gasketed to keep lamps and reflectors clean. Available for 6- or 8-ft HO, VHO or Power Groove fluorescent lamps. Also available are tapered square and octagon poles for mounting.

Mitchell Lighting Div., Compco Corporation, 1800 N. Spaulding Ave., Chicago 47, Ill.

Aluminum Boxes ((42)

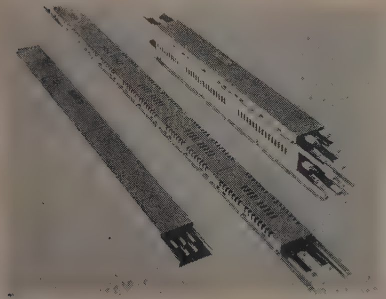
A complete line of aluminum boxes is now available. They are applicable for a variety of uses such as protective housing for relays, switches, terminal blocks, and other small electrical equipment.

Anderson Electric Corp., Leeds, Ala.

Switch **(43)**

A new Corbin lock switch has been added to the "Quiette" switch line. It has been designed for industrial and commercial use. By turning the key in a P. & F. Corbin pin tumbler lock, it will prevent unauthorized tampering with lights in industrial plants, theaters, auditoriums, schools, hospitals, institutions and public buildings. It is available in 15- or 20-amp, 120-277 volts, ac only, single pole, double pole and 3-way. Both 15-amp and 20-amp styles are full rated.

Arrow-Hart & Hegeman Electric Company, Hartford, Conn.



Busways **(44)**

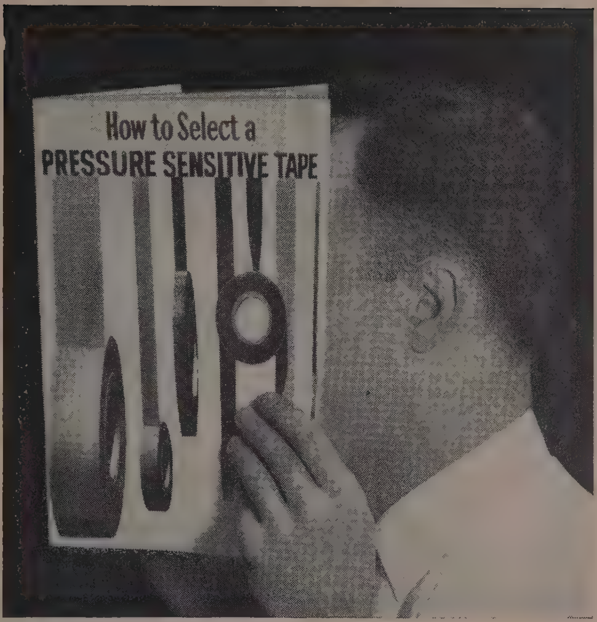
An improved line of Uni-Bus feeder and plug-in busways featuring a new type of construction, called "Polyair Insulation," has been announced. It is now standard on the Uni-Bus line of busways which consists of various types of low-impedance insulated busbar systems, designed for complete electrical and mechanical interchangeability. Available in ratings from 60 to 4,000 amps, Uni-Bus busways are fully enclosed sources of light and power supply which are tapped through standardized plugin connections.

Electric Distribution Products, Inc., Allentown, Pa.

Transformers **(45)**

Three new lightweight transformers in 500, 333 and 250-kva ratings have been announced. The 500 is 50 in. high. The lighter, more compact core and coil extend the usefulness of this transformer, and its dual ratings of 333 and 373 permits a 12% increase in kva operating load with no loss of expected life. The 250 has an overall height of 32 in. It features SPI-65 super insulation and dual ratings with a 12% increase in operating kva.

Kuhlman Electric Co., Birmingham, Mich.



Free booklet tells you what to look for in a pressure-sensitive tape

Here's a handy, new booklet that gives clear, concise answers to nearly any pressure-sensitive tape problem. It's based on Johns-Manville's long years of experience in the manufacture of tapes for electrical and industrial applications. It's called "How To Select A Pressure-Sensitive Tape," and tells you how to effect important economies; help speed production; eliminate knotty mechanical difficulties. It tells:

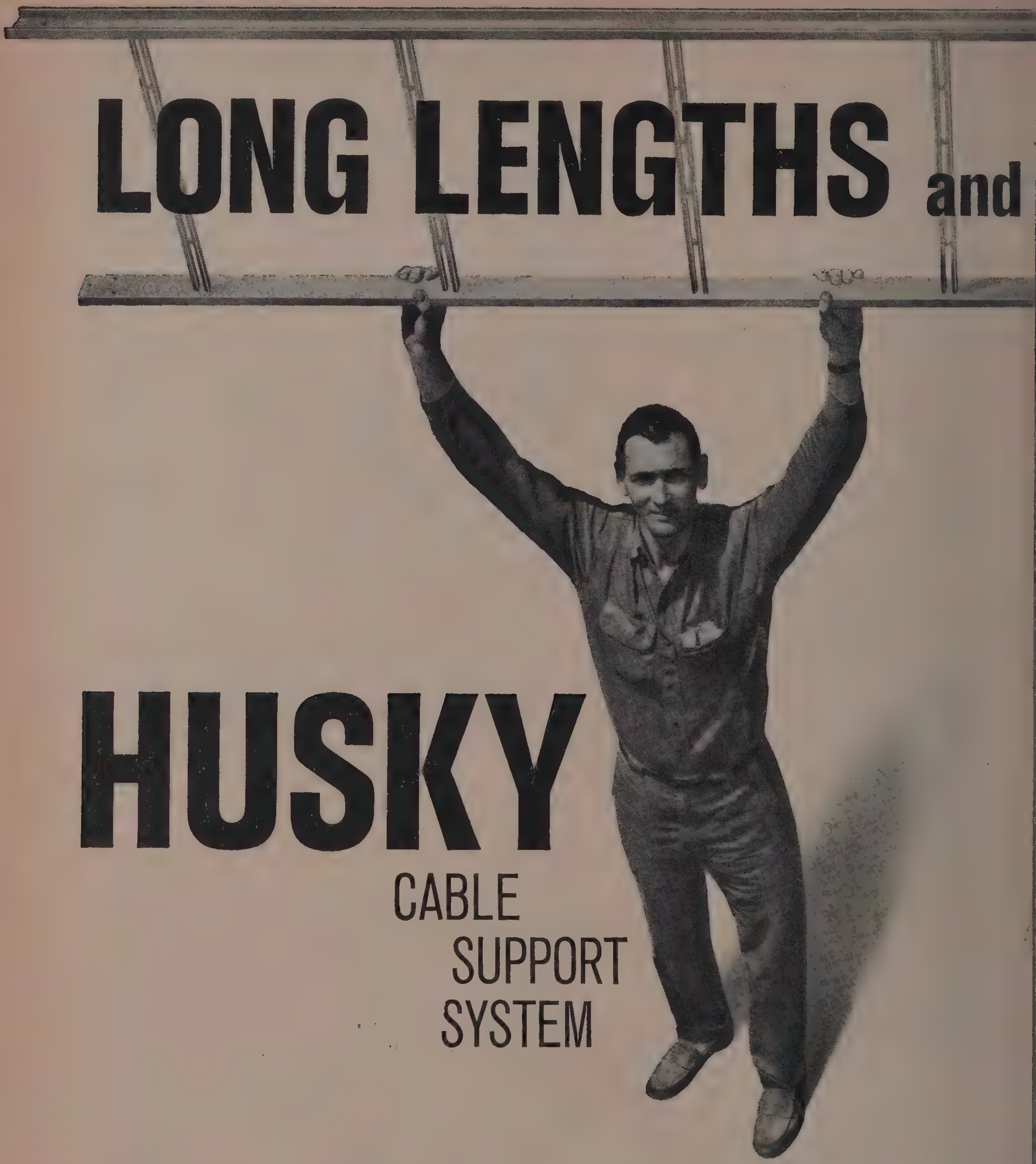
- Why the adhesive qualities of a tape are as important as the backing material.
- What causes tape failure; and how to prevent it.
- A glossary of terms associated with pressure-sensitive tapes.
- A complete list of authoritative technical data files available.

JOHNS-MANVILLE
DUTCH BRAND® TAPES
BOX 14, NEW YORK 16, N. Y.

Please send me a free copy of "How To Select A Pressure-Sensitive Tape."

NAME____________________
ADDRESS____________________
CITY____________ZONE________
COUNTY____________STATE________

LONG LENGTHS and



HUSKY

CABLE
SUPPORT
SYSTEM

ELECTRICAL CONTINUITY. Faults grounded safely thru low-resistance rung and splice joints.

Send for electrical continuity data.

LONG SPANS...

...provide LOWEST INSTALLED COST with this maintenance-free aluminum cable support system.

LONGER LENGTHS. HUSKY'S 24-foot aluminum sections—replacing 12-foot steel sections—mean half as many units to handle, half as many splices to make. Yet a HUSKY section is easier to handle than a steel section half the length!

LONGER SPANS. Design with high-strength 6063-T6 aluminum alloys permits longer spans, intermediate supports and support installation labor reduced by 50% or more.

MAINTENANCE-FREE. Use of aluminum alloy permits maintenance-free installation under practically all atmospheric conditions.

SINGLE SOURCE. All cable carriers, support hardware, cable clamping devices, installation tools—even structural towers and bridges—from one source of supply with unit responsibility.

ENGINEERING SERVICE. Complete engineering services available for take-offs, mark-up of your drawings, or installation layouts.

HUSKY PRODUCTS, INC. — division of **BURNDY** CORPORATION

5300 Vine Street, Cincinnati 17, Ohio

61-20

I'VE SEEN IT—
YOU'LL LIKE
THIS NEW LINE

Ollie Windhorst, owner, Reddy Electric Co., Inc., Louisville, Kentucky

General Electric's new decorator room thermostats engineered for precise electric comfort heating control.

Handsome new room thermostat is a style leader in the pacesetting all-new line of electric comfort heating equipment—designed, engineered, and *manufactured* by General Electric. In brushed aluminum on ivory, the smart new thermostat has the same fresh look and dimensions as the popular General Electric decorator wall switch plates.

Extremely sensitive to both radiant and air temperature, differential is only ½ degree F. range 55 to 85 degrees F. Available in single pole with temporary shutdown position, and double pole with off position. High capacity with 5000 watts at 240 volts AC. Mechanical temperature locking device optional for both models.

FREE LITERATURE: for complete details and specifications, write 49-115-1, General Electric Company, Electric Comfort Heating Section, Appliance Park, Louisville 1, Kentucky.

280-04

New thermostat blends with popular G-E decorator wall plates.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Catalogs & Bulletins

(46) Heaters Bulletin DB5-100 provides information on electric unit heaters with capacities from 1½ to 36 kw. Ilg Electric Ventilating Co.

(47) Ventilator. 8-page Bulletin DB3-100 covers propeller fan power roof ventilators. Ilg Electric Ventilating Co.

(48) DC Power Supply. Bulletin AC-61 describes new 1961 line of static dc power supplies. Christie Electric Corp.

(49) Photocells. A new industrial application leaflet entitled "Can Photocells Do the Job for You?" contains a report of typical production problems solved with electric eyes. Photomation, Inc.

(50) Pump Drives Bulletin F-2002 covers all the various lines of U. S. pump motors and drives. U. S. Electrical Motors, Inc.

(51) Grounding Switch. Bulletin PPSE-110 describes new Type PGH high-speed grounding switch including application information, design and operating features, and accessory information. Line Material Industries, McGraw-Edison Co.

(52) Miracle Door Troffers 44-page handbook of recessed fluorescent equipment features modular troffer units with frameless plastic lenses and a wide variety of other shieldings. Globe Lighting Products, Inc.

(53) Refractors. "Design and Application of Holophane Prismatic Street Lighting Refractors" presents design considerations and application information. Holophane Co., Inc.

(54) Industrial Switches. Bulletin 201 provides complete technical data on the full line of Loxswitch industrial limit switches. R. B. Denison Manufacturing Co.

(55) Ballasts for indoor and outdoor applications are described in 12-page Bulletin FL-370A entitled "Sola Fluorescent Lighting Ballast Buyer's Guide." Sola Electric Co.

(56) Time Controls. Basic manual on time controls entitled "Basic Timing Instruction Manual" contains an explanation of time controls and circuitry. Haydon Div., General Time Corp.

(57) Portable Infra-red Heater, called "Infra-Glo," is described in Bulletin 30-C-44. Apextro Products Co.

(58) Convection Ovens. 4-page Bulletin GED-4329 describes new controlled convection wire enameling ovens for magnet wire enameling. General Electric Co.

(59) Electrical Supports. 24-page Catalog 10-1 illustrates basic slotted channel, fluorescent hanging systems and fittings; beam clamps, concrete inserts, framing fittings for every electrical support need. Power-Strut Div., Van Huffel Tube Corp.

(60) Yard Lighting. Lighting for gardens, patios, pools, shrubs, sidewalks and driveways is illustrated in Floralite brochure. Steber Div., Pyle-National Co.

(61) Range Hoods and ventilating fans are described in Bulletin 298-L. Leigh Building Products, Div. of Air Control Products, Inc.

(62) Insulators. Bulletins TIA-182 gives detailed information on the features and applications of new Locke Line post insulators. General Electric Co.

(63) Fans and Heaters. 10-page catalog describes complete line of exhaust fans, blowers and ceiling heaters. Emerson-Pryne Co.

(64) 600-Volt Switchgear. Advanced design features of 600-volt switchgear with K-Line circuits breakers are described in 20-page Bulletin 3200-1A. I-T-E Circuit Breaker Co.

(65) Lighting. 16-page brochure describes ornamental chandeliers with built-in sound sources. Soundolier Manufacturing Co., Inc.

(66) High-voltage Test Sets and power supplies are described in 8-page catalog. Peschel Electronics, Inc.

(67) Time Controls. Series 4000-SZ "Astro-Dial" time controls, with "follow the sun" operation, are described in Bulletin 6022. Paragon Electric Co., Inc.

NEW!
OSTER
QUALITY BUILT
SEWER AND DRAIN CLEANING EQUIPMENT

NO. 420 POWER MACHINE
Ideal for handling 3″ to 12″ building and main sewer lines. Choice of three different set-ups for use with basic 420 machine (1) Drum Dolly, as illustrated (2) 15 foot cables with quick connect—disconnect couplings and (3) regular coil container.
SEE IT TODAY!

NO. 320 POWER MACHINE
The perfect portable power machine for clean-out of 1½″ to 4″ waste lines. Drum handles 100 feet of OIL TEMPERED ½″ cable. Fast, efficient one-man operation.

OSTER DRAIN CLEANERS, HAND AND POWER

OSTER OFFSET HANDLE CABLES

This newest line not only includes a complete array of new Hand and Power Sewer Cleaning Equipment but also Oster's special formula Drain Solvents and Root Disintegrator. Write today for complete new catalog.

THE OSTER MANUFACTURING COMPANY
1313 E. 289th St., WICKLIFFE, OHIO, U.S.A.

Dorothy Collins' bright idea...

PLUG INTO MORE HOUSEPOWER PROFIT FROM NATIONAL ADVERTISING

"With Full Housepow
Wiring we can run a
our appliances witho
worry about blowing

The Byron C. Miller family of
Pennsylvania, are among the th
American families who are now en
delightful benefits of Full Housepow

THIS GOLD MEDALLION

YOU LIVE BETTER ELECTRICALLY

THIS FALL you get the biggest support ever for your HOUSEPOWER PROFIT PARADE—a double-page spread by Edison Electric Institute's Live Better Electrically Program in the September 30 issue of Saturday Evening Post, backed up on the very next page by the National Wiring Bureau's message from Dorothy Collins.

WHAT'S MORE, several local organizations are plugging their own electrical contractors in the same issue – substituting their own advertisements *regionally* (see above right) in place of the National Wiring Bureau's message. Among these are: Michigan Electrical Industry Association, North Central Electrical League, Baltimore Gas & Electric Co., Valley of the Sun Electric League.

PLUG INTO PROFIT!

There's a complete HOUSEPOWER promotion kit ready for you, including reprints of these great advertisements. For full details, simply clip the coupon below and mail, today.

NATIONAL WIRING BUREAU • A SPONSOR OF

HOUSEPOWER

The National Wiring Bureau
155 East 44th Street
New York 17, N.Y.

Please send me details on how to take advantage of the Saturday Evening Post HOUSEPOWER advertising this fall.

*Name*________________
*Company*________________
*Address*________________
*City*________ *Zone*____ *State*______

ECM-71

ROLL CALL!

Check The Record

☐ More miles in use underground than any other fibre conduit. ☐ oldest installations ☐ some go back 60 years and are still going strong. ☐ wide acceptance... ☐ by power and light utilities ☐ by telephone companies ☐ general contractors ☐ industry ☐ also by cities and municipalities ☐ first fibre conduit—we introduced it in 1893. ☐ first C. A. Conduit (coupling attached) ☐ first Klean-Kote for cleaner handling.

When anyone pays us the compliment of calling some other make of fibre conduit "orangeburg type" please remember that "orangeburg type" does not mean Orangeburg Brand Fibre Conduit. That's the brand and quality made by us alone.

Vital electrical cables deserve the best protection and we have spent nearly 70 years trying to make Orangeburg Brand Fibre Conduit the best that money can buy.

"No substitute is as good as the regular" it tries to replace.

KLEAN-KOTE*
ORANGEBURG®
BRAND
FIBRE CONDUIT

FLINTKOTE®

*KLEAN-KOTE IS A TRADE-MARK, U. S. PATENT APPLIED FOR.

Orangeburg Manufacturing Co., Orangeburg, New York. Division of The Flintkote Company, Manufacturer of America's Broadest Line of Building Products
Orangeburg Klean-Kote is distributed by Graybar Electric Company and General Electric Supply Company with Branches and Stocks in Principal Cities.

Reader's Quiz

QUESTIONS from readers on problems of industrial equipment, installations, maintenance and repairs. Answered by electrical maintenance engineers and industrial electrical contractors out of their experience. For every question and every answer published we pay $5.00.

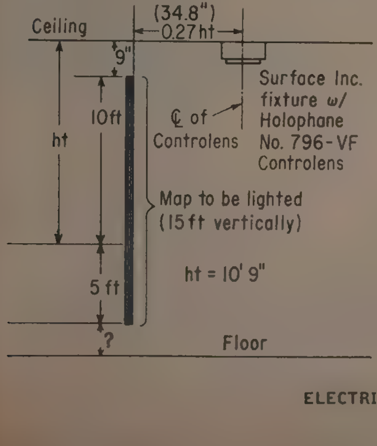
Lighting Problem

QUESTION P39—On a military camp design we ran into the problem of illuminating, with an evenly distributed 35 fc, a highly reflective surface—a 15-ft-high swinging map, covered with Plexiglas. The map, located in full width along a wall in a room of 400 sq ft, swings into two parts, 90 degrees away from the wall on two curved rails, which are hanging 9 in. below the concrete ceiling. With fixtures recessed in the concrete ruled out, what type of illumination could be considered as the best solution?—L.H.H.

ANSWER TO P39—One of the essential items you did not mention is the width of the wall that contains the map. As a result, the exact number of lamps cannot be determined. However, a general description of what can be used to solve the problem can be discussed.

Standard, surface-mounted incandescent fixtures are available for lighting vertical surfaces as in your case. Several manufacturers offer such units, and a typical luminaire is made by Holophane, with units containing a No. 796-VF Controlens. The Controlens concentrates the light in one plane (up and down the vertical surface) and spreads the light in a plane of 90° (along the length of the surface). A glance at the manufacturer's light-distribution curves verifies this. The sharp angle at which the light is directed to the surface completely removes annoying specular reflection.

Location of these fixtures should be as indicated in the accompanying sketch. Spacing between fixtures should not exceed 1¼ times the distance "ht" shown in the sketch. This is a maximum spacing, and for increased footcandles, fixtures should be installed end-to-end or in a continuous troffer for the width of the map. Lamps used in these units are 100- or 150-watt I.F. incandescents. This should approach your requirement of 35 fc. And if you desire greater intensities of light, larger wattage units should be selected. Again refer to the manufacturer's data sheets, and it is advisable to contact their engineering department, providing them with a detailed sketch of the map arrangement, clearances and measurements.


Ceiling
(34.8")
0.27ht
9"
Surface Inc. fixture w/ Holophane No. 796-VF Controlens
℄ of Controlens
10ft
ht
Map to be lighted (15 ft vertically)
ht = 10' 9"
5 ft
?
Floor

Another approach to the problem would be the use of some 20-amp plug-in or trolley busway, cord-connected to the 115-volt supply. Use swivel-type sockets of a type designed for the particular busway. Then install PAR and/or R lamps of various sizes (75 to 300 watts). By trial and error, determine how close the units should be placed to the vertical plane of the map, and what lamp sizes and types will provide the best results. With this flexible arrangement, lamps can be re-positioned quickly and additional lights can be installed easily. A little experimenting along this line should produce the exact result you are after.—E.G.B.

Fuse Voltage Ratings

QUESTION Q39—Is the ampere rating of a NEC or current-limiting fuse altered if the fuse is used in a circuit whose voltage is appreciably above or below the voltage rating of the fuse, and if so, why?—R.E.B.

ANSWER TO Q39—The ampere rating of NEC and current-limiting fuses is altered if the fuse is used in a circuit whose voltage is appreciably different from the design rating. A higher voltage fuse may be used in a circuit operating at a lower voltage but never the reverse. For example, if the short-circuit interrupting current on a given circuit was too high for the largest 250-volt HIC fuse, the manufacturer might well recommend the use of a proper size HIC fuse rated at 600 volts.

Fuses are selected on the basis of continuous-current rating, interrupting-current rating, speed of response and the voltage rating. The voltage rating is not a measure of its ability to withstand a certain potential when a given number of amperes is flowing. It is the ability to interrupt the arc voltage which is much higher, and maintain this interruption, i.e. prevent it from restriking.—T.M.S.

ANSWER TO Q39—The ampere rating of a fuse is not affected by voltage. Current is what it responds to. Operating a fuse in a circuit below the voltage rating of the fuse, will have no adverse effect on it.

However, you can get into serious trouble using the fuse in a circuit above the voltage rating of the fuse. Under fault conditions the voltage across a fuse can approach the circuit voltage. The fuse is designed to operate at or below its voltage rating. If the voltage across the fuse is above its voltage rating, it may not interrupt the current safely, and it can continue to arc across, or it may blow up altogether.—W.E.G.

ANSWER TO Q39—The current rating of a fuse does not vary as the applied voltage is changed. The melting point of a fuse is depending on the circuit current or the power is absorbed by a fuse, $P = I^2R$, the fuse resistance is constant.

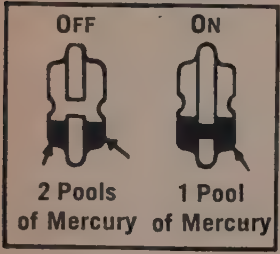
The voltage rating of a fuse is only a safety limit in order to prevent shattering, or burning up when a short circuit occurs, or sparking might occur between both ends, if it is used in a circuit that is above the safety voltage rating.—S.Y.

3-Phase Motor Connections

QUESTION R39—On a dual-voltage Y-motor, 220/240 volts, 3-phase, 60 cycles, where all the identification has been obliterated on all nine leads, is there a quick method

Switch to

General Electric Silent
and smoothly as a



COMPLETELY SILENT—ONLY ONE MOVING PART!

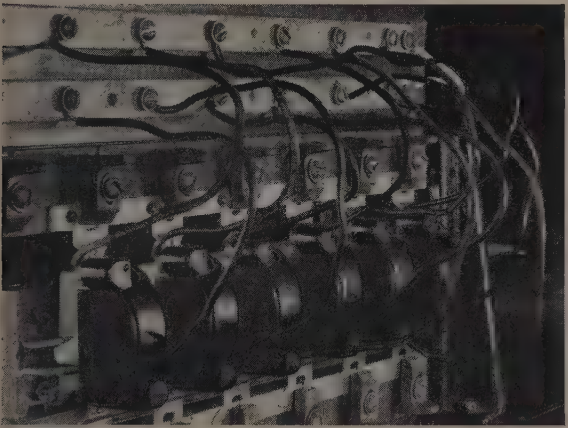
The round button in this G-E Silent Mercury Switch turns without a whisper when you flip the handle. And it's the **only** moving part.

There's nothing to **snap, click** or **pop**—just two pools of mercury flowing together or apart, inside the button, for ON and OFF.

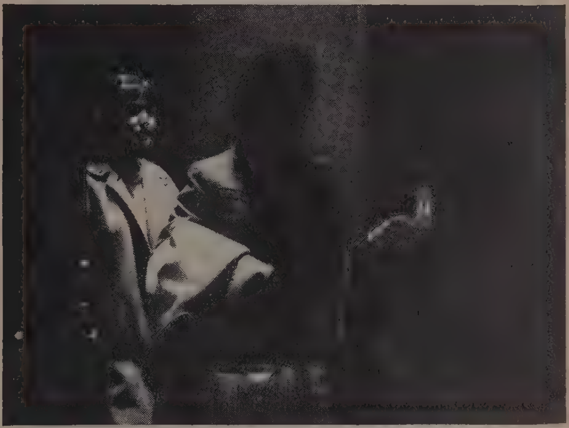
So-called "quiet" type switches with mechanical contacts can never equal this soft, liquid action—in complete silence—in comfortable feel—in freedom from wear and breakdown.

Silence!

Mercury Switches operate as silently thermometer: last for years and years

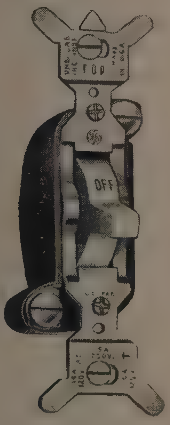


LAST YEARS LONGER THAN SNAP-TYPE OR "QUIET"-TYPE SWITCHES G-E Silent Mercury Switches have been turned ON—OFF, ON—OFF more than 1,000,000 times without failure! Lab tests indicate their average life is 500,000 cycles — some 14 times the required life of ordinary switches.



No groping! You can find these switches in the dark.

For bathrooms, basements, storerooms, halls and other often-dark spots, G-E Silent Mercury Switches are available with lighted handles. Built-in lamps "locate" these switches; also show when circuits are OFF.



Regular (non-lighted) switches available with brown or ivory handles—single-pole, double pole, 3-way or 4-way. Lighted-handle switches available with ivory handle—single pole or 3-way. Listed by Underwriters' Laboratories, Inc., meet Federal and REA specifications.

TOP QUALITY—REASONABLE IN COST These silent General Electric switches are Specification Grade: can be used to full 10A-125V T- and 15A-120V AC- ratings for tungsten filament and fluorescent lamp loads. They cost little or no more than other high-quality switches, usually cost less per year of service.

SWITCH TO SILENCE! Suggest G-E Silent Mercury Switches for homes, motels, stores, offices, industry—anywhere complete silence, long life, or luxury-smooth action in a switch will be appreciated.

General Electric Company, Wiring Device Dept., Providence 7, Rhode Island.

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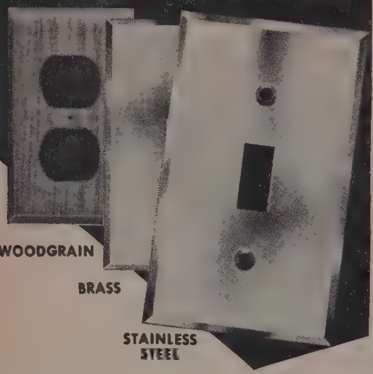
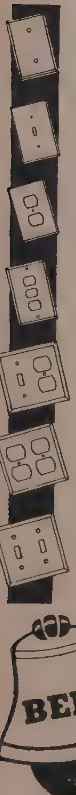


America's Largest Most Complete Line

Specification Quality!



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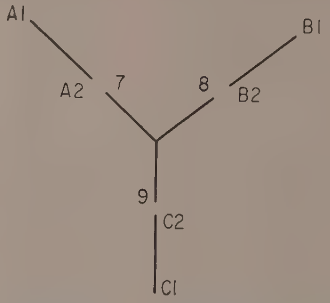
of re-identifying them properly and re-connecting them?

We can get three pairs that read through: such as No. 1 and No. 4; No. 2 and No. 5; No. 3 and No. 6. But how do we find which are numbers 1-2-3, and how do we find numbers 7-8-9?—H.R.B.

ANSWER TO R39—Here is the procedure we use to identify the leads of a dual-voltage Y-connected motor.

1. Find the three leads between which continuity may be obtained and tag permanently 7, 8, and 9.
2. Find the other three 2-wire coils and tag according to diagram.



3. Apply lowest nameplate voltage to permanent leads 7, 8, and 9. Motor should operate. Make sure all other leads are disconnected and there is no load on motor.
4. Take voltage readings across each of the three 2-wire coils. There should be an induced voltage of 58% of line voltage.
5. Connect A-2 and 7. Operate motor with line still connected to 7, 8, and 9. Take voltage readings between A-1 and 8, and A-1 and 9.

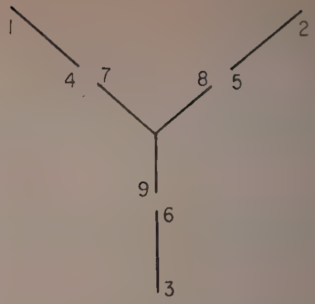
Three sets of different readings are possible.

a. If readings are about equal and 150% of line voltage, tag A-1, lead 1 and A-2 lead 4 permanently.

b. If readings are 58% of line voltage tag A-1, lead 4, and A-2 lead 1 permanently.

c. If voltage readings are unequal, connect B-2 and 7. With lines still connected to 7, 8, and 9, run motor and take readings between B-1 and 8, B-1 and 9. If neither a 58% or 150% of line, voltage reading is present, connect C-2 and 7. You should by now have either a 58% or 150% reading. Unless the 58% or 150% reading is present we do not have the half-phase connected to its other half. Tags become permanent when we have a 150% reading.

6. Apply procedure under "5" to the two remaining circuits. Finished diagram should now be numbered according to this diagram.

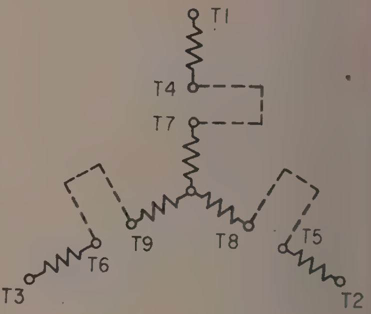


7. After all leads have permanent tags connect 4, 5, and 6 together. Apply lowest nameplate voltage to leads 7, 8, and 9. Read voltage between 1, 2, and 3, which should be about equal to 100% of line voltage.

Going a step further (step 5, paragraph c), we find all we are really doing is finding out if A-2 goes with 7, 8, or 9, B-2 with 7, 8, or 9, or C-2 with 7, 8, or 9. With a 150% voltage reading, tags become permanent. With a 58% voltage reading, reverse A-1 and A-2, B-1 and B-2, or C-1 and C-2 whichever the case may be.—C.R. and J.D.S.

ANSWER TO R39—To properly re-identify the leads of a dual-voltage Y-connected 3-phase 220/440-volt 60-cycle motor proceed as follows:

1. The nine leads should be tested out with a lamp or buzzer, and the three leads on the common circuit forming the internal star should be permanently tagged as shown:



2. Connect leads T_7—T_8—T_9 to a 220-volt 3-phase power source and with lead T_7 connected to lead T_4, measure the voltage between T_1 and T_8 and between T_1 and T_9. Then proceed as follows:

a. If these two voltages are the same and about 335 volts, leads T_1 and T_4 can be permanently marked.

b. If these voltages are both the same value but equal to 127 volts, interchange the markings T_1 and T_4.

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COLOR-CODED SHERARDUCT*
rigid steel conduit
*Galvanized Conduit at its BEST . . . and MVC-1 Poly-Vinyl protected.

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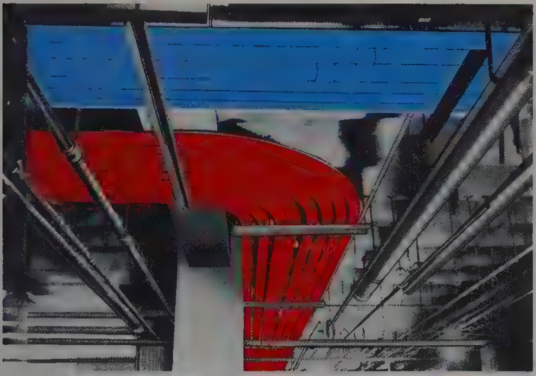
The best way to put power in place

Now you can have Sherarduct, the industry's standard in Galvanized Conduit, factory-coated in five colors that make location and identification of electrical runs simple and easy.

New Color-Coded Sherarduct makes it possible for you to separate conduit runs from water, steam, air and other service lines. Within your electrical distribution systems, new Color-Coded Sherarduct lets you color the runs to indicate type of service and voltage, makes your system more flexible by cutting the time needed for relocation and modernization.

NEW from NATIONAL ELECTRIC — Color-Coded Sherarduct . . .
Galvanized Conduit With These EXTRA Features



DOUBLE PROTECTION. Color-Coded Sherarduct gives you extra protection against rust and corrosion. More than just a "dip", Color-Coded Sherarduct is made with National Electric's exclusive Sherardizing process in which pure zinc is alloyed with the steel and threaded ends of the conduit.

After the zinc alloying, Sherarduct is immersed in a bath of MVC-1 Poly-Vinyl to which special, extra quality, color pigments have been added. MVC-1 Poly-Vinyl is recognized as an excellent protector against corrosion.

Outside, MVC-1 Poly-Vinyl envelops the zinc-coated surface, and the added color makes identification permanent.

Inside, MVC-1 provides a lasting, smooth surface for the easiest fishing possible.

ELIMINATES PAINTING. With Color-Coded Sherarduct, you eliminate the cost of on-the-job painting. Your finish is neater than ordinary surface coating and can be matched to the job. You can specify five basic colors or order special colors to match the color scheme of the installation.

NO FLAKING OR PEELING. Color is on for life because it's part of the MVC-1 Poly-Vinyl finish. It's baked on, and the toughest on-site bending won't flake or peel the hard uniform surface of Color-Coded Sherarduct.

FITTINGS TOO! Because color and surface are factory-applied, you take advantage of the best. They're made under the most exacting manufacturing conditions possible. Even elbows and couplings get the same special attention.

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Color-Coded Sherarduct is available now in all standard sizes in Galvanized steel.

Each length comes to you with a coupling attached, and a plastic colored thread protector on the open end to indicate sizes.

Order your requirements now!

DIMENSIONS AND WEIGHTS

CONDUIT					
Nominal or Trade Size of Conduit (Inches)	Inside Diameter (Inches)	Outside Diameter (Inches)	Wall Thickness (Inches)	Length Without Coupling (Feet and Inches)	Minimum Weight of Ten Unit Lengths With Couplings Attached (Pounds)
½	0.622	0.840	0.109	9-11¼	79.0
¾	0.824	1.050	0.113	9-11¼	105.0
1	1.049	1.315	0.133	9-11	153.0
1¼	1.380	1.660	0.140	9-11	201.0
1½	1.610	1.900	0.145	9-11	249.0
2	2.067	2.375	0.154	9-11	334.0
2½	2.469	2.875	0.203	9-10½	527.0
3	3.068	3.500	0.216	9-10½	690.0
3½	3.548	4.000	0.226	9-10¼	831.0
4	4.026	4.500	0.237	9-10¼	982.0
5	5.047	5.563	0.258	9-10	1344.0
6	6.065	6.625	0.280	9-10	1770.0

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Birmingham, 205 American Life Bldg. (3)—Alpine 1-7021
CALIFORNIA
Fresno, 3242 N. Lafayette Ave.—Am 6-3675
San Francisco*, 400 Potrero Avenue, (10)—Underhill 1-1145
Los Angeles*, 6900 East Elm St. (22)—RAymond 3-0393
COLORADO
Denver*, 455 W. Wesley, (23)—Pearl 3-3741
DISTRICT OF COLUMBIA
Washington, Investment Building, (5)—National 8-3916-17
FLORIDA
Miami, 801 N.W. 79th Street, (38)—Plaza 7-8361
GEORGIA
Atlanta*, 1238 Fernwood Circle, N.E., (19)—Cedar 7-0336
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INDIANA
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Davenport, 612 Kahl Building—323, 7014
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New Orleans, P.O. Box 827, Mandeville, La.—Main 6-3512
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Detroit, 50 W. McNichols Rd., (3)—Tulsa 3-4600
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Kansas City, 6225 Brookside Blvd., (13)—Emerson 1-8070
St. Louis, 4903 Delmar Boulevard (8)—Forest 1-4641
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New York City, 300 Park Avenue, (22)—Murray Hill 8-2700
Syracuse, State Tower Building, 109 S. Warren St.—Harrison 2-5997
NORTH CAROLINA
Charlotte, 108 Robinson Building, 121 E. Third Street, (1)—377-3375
OHIO
Cincinnati, 2534 Victory Parkway, (2)—University 1-7225
Cleveland, 1836 Euclid Avenue, (15)—Superior 1-2250
OREGON
Portland, 1785 S.W. Filmont Street, (25)—Mitchell 4-0463
PENNSYLVANIA
Philadelphia, 325 Chestnut Street, (6)—Walnut 5-2635
Pittsburgh, Porter Building, (19)—EXpress 1-1800
TEXAS
Dallas, 6033 Berkshire, (25)—Emerson 8-7385
Houston, 3810 Westheimer Road, (27)—Madison 3-3642
UTAH
Salt Lake City, 19 West South Temple, (1)—Davis 2-2701
VIRGINIA
Richmond, 3122 West Clay Street, (30)—Elgin 3-6758
WASHINGTON
Seattle, 906 First Avenue, South, (4)—Main 3-3775
WISCONSIN
Milwaukee, 6228 West Capital Drive, (16)—Hopkins 1-5757

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*Warehouse location.

PORTER

NATIONAL ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.

PORTER BUILDING, PITTSBURGH 19, PA.

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. Porter Company, Inc., Pittsburgh, Pennsylvania

c. If the voltages are equal to less than 335 volts or are unequal, disconnect lead T_7 from lead T_4 and connect to lead T_5. Now measure the voltages between (T_2 — T_8) and (T_2 — T_9). If the same and equal to 335 volts, the leads temporarily marked T_2 and T_5 can be permanently marked as T_1 and T_4.

d. Changes and measurements should be made for each of the two remaining circuits until a position is found at which the two voltages on each coil, are equal to and about 335 volts. The leads T_2, T_5, T_3, and T_6 can now be permanently marked.

3. If the above steps have been done correctly the motor can be permanently connected as shown by the dashed lines and be put into operation.

With this method be sure any mechanical load is disconnected from the motor.—H.E.H.

Can You Answer These QUESTIONS?

QUESTION A40—I have a problem which has everyone in our shop stumped. At one of our industrial accounts, which has a 240-volt, 3-phase, 3-wire, 1600-amp service, we get unusual voltage readings from phase to ground. These are A to ground 270 volts, B to ground 150 volts, C to ground 115 volts. We put two 100-watt lamps in series across phase A and ground, and we get an arc but no light, and the voltage meter drops from 270 volts to 0. We have checked our meter.

I have heard a theory that this is a phantom voltage, but I cannot understand the increase over the service voltage of 240 volts.—T.R.M.

QUESTION B40—We are actively considering the installation of movable metal partitions that have wireways built into the base where both the power and phone cables are to be run.

The phone company is asking for a 4-in. separation between the phone cable and power wires. Now this is impossible in a 3-in. metal partition.

1. What portions of the NEC cover this type of installation?

2. What effect will the closeness of the power cables have on the telephones?

3. What other problems can we anticipate in this installation?—J.A.M.

QUESTION C40—What is the difference between a 240-volt, 3-phase part-winding motor, and a 240/480-volt motor as far as the windings are concerned? It seems to me that the 240/480-volt motor on the lower voltage can also start on one winding and run on two windings.—H.S.

QUESTION D40—In a recently completed plant, we are having difficulty with mercury-lamp ballasts blowing fuses for no apparent reason. The fuses are installed in the ballast terminal boxes and are solely for the purpose of indicating which ballast is faulty. Each of the constant-wattage ballasts supplies two 400-watt H331GL/C lamps, and there are 12 such ballasts on each 30-amp, 3-phase branch circuit, balanced across the phase conductors of a 480/277-volt grounded system. Ballasts are rated 400 to 520 volts input, 1.9 amps.

Switching is done by means of a 3-pole contactor for each 3-phase branch circuit. Five-amp fuses are blowing frequently, and the only pattern we can detect is that as many as five fuses on a circuit have blown when the circuit was opened and immediately reclosed, in spite of the fact that starting current for this ballast is less than operating current. Fuses also have blown during normal continuous operation. The following steps have already been taken:

1. Suspicious ballasts have been checked, found okay.

2. Terminal box temperature, 122°F, has been declared not responsible (by fuse manufacturer).

3. Fuse connections have been checked and found okay.

4. Ballast manufacturer has set up a laboratory test and is unable to find excessive current.

5. System voltages have been checked and recorded. (470 to 458)

6. We have substituted 10-amp fuses in over a hundred cases, and none of these have blown, nor have the ballasts given trouble.

7. No lamps have burned out, nor have any of the 30-amp branch-circuit fuses blown.

What would you suggest next, in order to enable us to use fuses small enough to blow when a ballast fails before the branch-circuit fuse blows?—W.S.W.

PLEASE SEND IN YOUR ANSWERS BY AUGUST 15

Hanging Fixtures?

Just ATTACH . . . HANG . . . TWIST

FOR 4" and 4½" BOXES

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SIMPLE, EASY, SWIFT . . . screw hanger on box—forget alignment . . . hang fixture on small, compact arms . . . then, align fixture instantly with a twist of the wrist!

EXCLUSIVE FRICTION RING suspension rotates all the way around, 360°

10 RECEPTACLE CHOICES—one for every job—an Ideal exclusive.

BRIGHT CADMIUM PLATED for neat, attractive installations.

HANGING CAN BE DONE with 2 or 4 chains, or S hooks.

"LOW COST" HANGERS ALSO AVAILABLE
38° swing. Ground fixtures to systems. 2 or 3-wire models. 2 5'-chains. Hooks and cord clips supplied.

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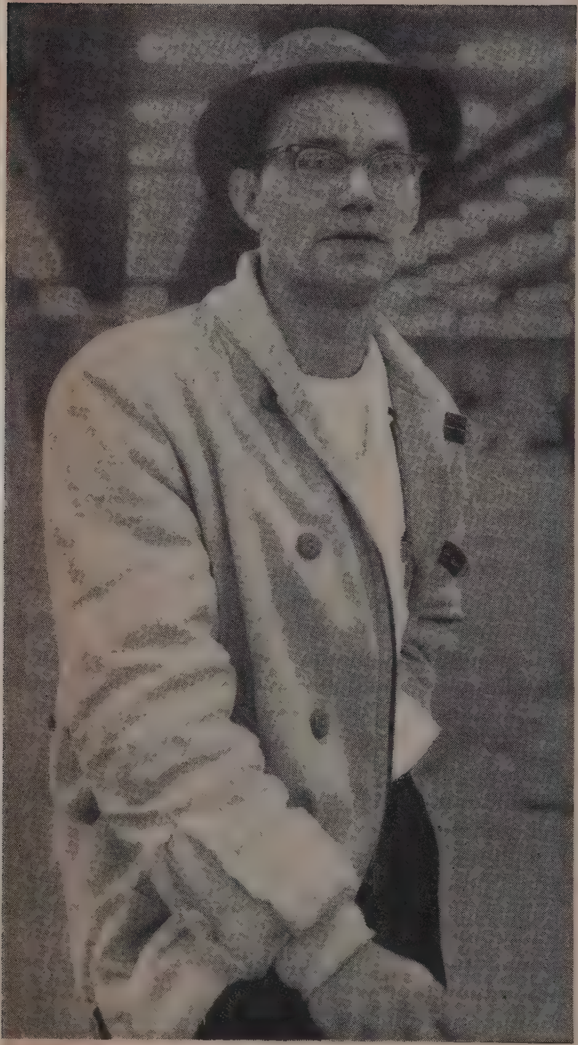

"On this warehouse job GREENLEE ONE-SHOT BENDERS cut bending time 80% for 1-1/2 to 3-1/2" diameter aluminum conduit,"

says ELMER BERINGHAUS,
field superintendent,
BECKER ELECTRIC COMPANY,
Cincinnati, Ohio

"Using Greenlee tools on this electrical contract enabled us to make neat, professional conduit installations in less time and with fewer couplings and fittings," reports Elmer Beringhaus, field superintendent for Becker Electric Company of Cincinnati.

"With our new Greenlee one-shot bender, a 90° bend in 3½" aluminum conduit takes about six minutes compared with 30 to 40 minutes using our previous method . . . a timesaving of 80% on every bend."

"We had to make nearly 300 bends in conduit ranging from 1½ to 3½" in diameter on this warehouse and service area job. A large percentage of the conduit was put in before the concrete floor was poured," Beringhaus stated. "Heavy, hard-to-move benders were out of the question in the kind of mud we had here. We selected a Greenlee bender because it's rugged, lightweight, and fast . . . and one man can move it and set it up. It has proved ideal for the type of on-the-site work we had on this contract."

See the facing page for pictures and stories of how Greenlee Job-Profit Tooling saved time and money on this $150,000 electrical contract.

"One man now does the work of two using the Greenlee No. 884 lightweight hydraulic one-shot bender for pipe and conduit. Our old benders required as many as 20 or 21 shots to make a 90° bend in 4″ stock," Superintendent Beringhaus reports. "And two men were needed to align and level the conduit after each shot. Sometimes a complete bend had to be rejected because it wasn't smooth or level. This cost us time and money.

"With our new Greenlee one-shot, one man can make the setup and complete a 90° bend in aluminum pipe in about 1/5 the time formerly required — a substantial saving over our previous method." As the picture above shows, Becker powers its benders with a Greenlee No. 798 AC-SA hydraulic power pump. This pump is known throughout the industry for dependable, maintenance-free performance.

"The fast accurate way to make openings in junction boxes," states Beringhaus, "is with Greenlee knockout tools. We used a Greenlee No. 7310 hydraulic knockout punch driver and the punch sets shown here to make more than 200 conduit openings ranging from 1¼ to 4″ in diameter. The fast cutting action of these units makes punching clean, uniform openings a snap."

The tools Becker Electric Company uses must be light, mobile, and fast-acting. They also must be able to take a real beating, as this job proved. Albert Osborn, Becker purchasing agent, reports that "there have been no repairs or maintenance on any Greenlee equipment used on this job."

Two new additions to the Greenlee line of Job-Profit Tooling

NEW lightweight (14 lb) hydraulic power pump

The Greenlee No. 1729 pump is a handy power source for hydraulic knockout punch drivers, rams, jacks, pullers, and similar tools with high-pressure, low-volume requirements. Two speeds . . . fast approach. High pressure to 10,000 psi.

NEW pipe holders for Greenlee benders

Greenlee No. 1803 pipe holders, designed for use with Greenlee benders, prevent "wows" and "dog legs" during segment and offset bending operations.

Pipe holders clamp quickly to each end of the pipe to keep it level and parallel with bender shoes and pipe supports. One size fits pipe from 1¼ to 4″ in diameter.

GREENLEE JOB-PROFIT TOOLING includes over 100 different types and sizes of timesaving equipment designed to help electrical contractors streamline operations and control costs.

To learn how Greenlee tools assure extra efficiencies, better final results, *and more net profits,* see your Greenlee distributor . . . or write for Bulletin E-240A today.

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JOB-PROFIT TOOLING
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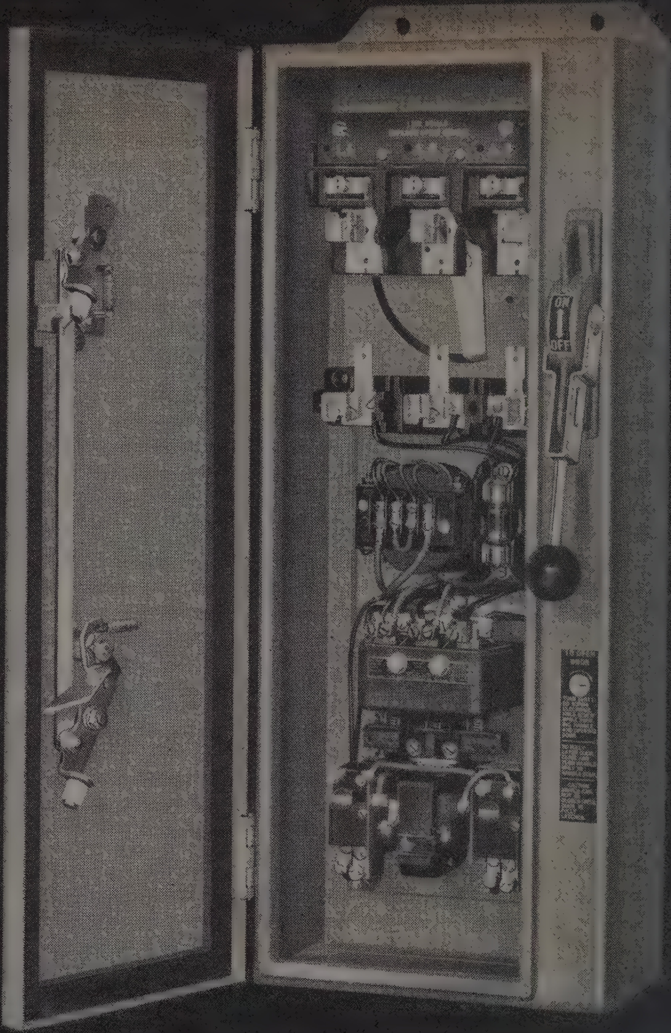
NEW
FROM CLARK

NEMA 12 SAFETY COMBINATION STARTERS WITH THREE EXCLUSIVE FEATURES



Safety fusible combination starters are gaining wide interest throughout industry. But only the new Clark line offers these important features:

- *New Clark-built visible blade disconnect switch with double-break, silver-alloy to silver-alloy contact surfaces*
- *Disconnect switch accommodates NEC or the new Class J Current Limiting fuses*
- *To simplify installation, complete unit can be removed from enclosure in seconds with no disassembly of handle mechanism*

New Clark Safety Starters offer non-teaseable, snap-action disconnect switch operation. Cabinet design permits only authorized persons to open door when switch is on, or to close switch when the door is open. Dust-tight operation is assured by interlock which requires door handle to be closed and door tightly latched before disconnect switch is operable.

These Clark Safety Fusible Combination Starters are available with interchangeable fuse clips to accommodate a full range of fuses, and are offered with famous Clark "CY" Contactors in sizes 0, 1, and 2. Designed for NEMA 12 (industrial) service, they also are suitable for NEMA 5 (dust-tight) applications. For information, call the nearest Clark distributor or sales office, or write: 61SCS1

THE CLARK CONTROLLER COMPANY

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IN CANADA: CANADIAN CONTROLLERS, LIMITED, TORONTO, ONT.

Questions on the Code

Answered by:

B. Z. SEGALL, *Consulting Electrical Engineer, New Orleans, La.*
R. E. WARD, *Chief Electrical Inspector, Insurance Department, State of Tennessee, Nashville, Tenn.*

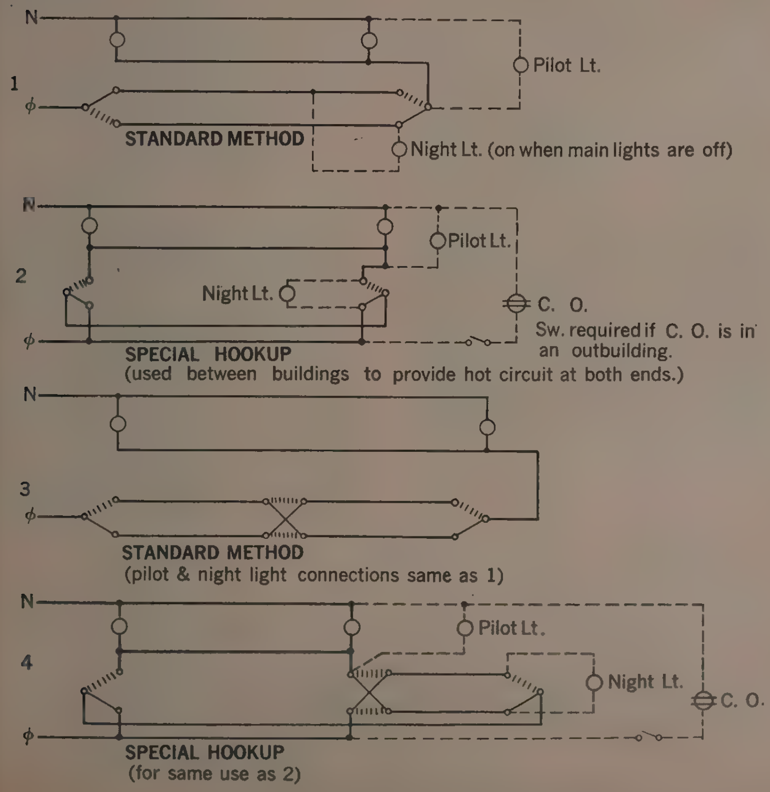
Reader's Comment

One of our alert readers draws our attention to a minor error that appeared in a diagram on page 101 of our March 1961 issue. In sketches 2 and 4 of the diagram, a single-pole switch was shown controlling a convenience outlet. However, the switch was inadvertently placed in the neutral conductor, whereas it should have been placed in the ungrounded conductor. In view of the interest expressed in the two special hookups (2 and 4), we are publishing a revised drawing, which contains the correction noted.

Our reader also asked what code section would require a switch to control the convenience outlet located in an outbuilding. The applicable rule is Section 230-76, which reads:

"More Than One Building. In a property comprising more than one building under single management, the conductors supplying each building served shall be provided with a readily accessible means, within or adjacent to the building, of disconnecting all ungrounded conductors from the source of supply. In garages and outbuildings on residential property the disconnecting means may consist of a snap switch, suitable for use on branch circuits, including switch controls at more than one point."

In the last sentence of Section 230-76, it should be noticed that switch controls (for residential outbuildings) at more than one point are considered to satisfy the fundamental rule of this particular code rule. However, while sketches 2 and 4 of the accompanying drawing show multiple switch control, these switches only disconnect the ungrounded conductor to the lighting outlets at each building. Therefore, it is essential that an additional switch be provided to disconnect the ungrounded conductor to the "hot" receptacle when these special hookups are used. And it is most logical to locate this switch in the outbuilding.—J.H.W.—7/61/1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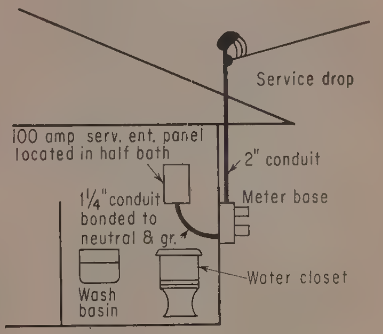
Pilot Lt.
STANDARD METHOD
Night Lt. (on when main lights are off)
N
2
ϕ
Pilot Lt.
Night Lt.
C. O.
Sw. required if C. O. is in an outbuilding.
SPECIAL HOOKUP
(used between buildings to provide hot circuit at both ends.)
N
3
ϕ
STANDARD METHOD
(pilot & night light connections same as 1)
N
4
ϕ
Pilot Lt.
Night Lt.
C. O.
SPECIAL HOOKUP
(for same use as 2)

Service Equipment In Lavatories

Q. *In a proposed installation in new construction, the question has arisen as to whether or not the placement of the 100-amp service-entrance breaker panel in a small half bathroom on the first floor of the house would be in violation of the code. See sketch below.*


Service drop
100 amp serv. ent. panel located in half bath
2" conduit
1¼" conduit bonded to neutral & gr.
Meter base
Water closet
Wash basin

The owners prefer the service entrance on the first floor for better accessibility, rather than having it in the basement.

The argument was raised that such a location would be dangerous to persons working at the breaker panel because of the proximity of water pipes. I could find nothing in the code that would prohibit such a location, but am wondering if I overlooked something. Any other location upstairs would not be desirable from the standpoint of appearance in the eyes of the owners.

Could you please tell me if such an installation would constitute a violation of the NEC.—F.N.N.

A. According to the provisions of Paragraph 230-70 (b), the service disconnecting means "shall be located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building wall."

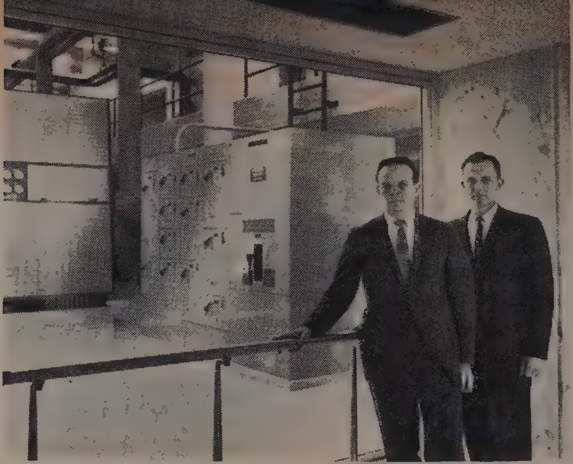
It appears obvious that the code does not attempt to specifically cover the rooms or areas where service equipment may or may not be installed.

This question was considered by Panel No. 3 of the electrical committee, back in 1955, when pro-

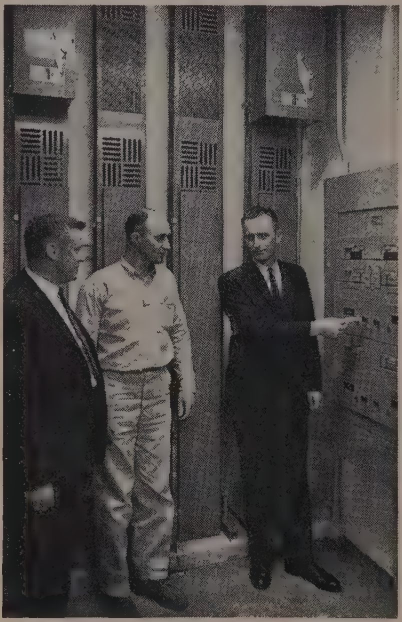
Under full control by Westinghouse... 23 watts p.s.f. in Georgia Power's all-electric building

Designed with an all-electric concept, the 22-story **270 Peachtree Building**—Atlanta's newest skyscraper—serves as headquarters for the Georgia Power Company. Some of the electrical statistics:

Service voltage—266/460
Service entrances—Two 4,000 ampere bus duct runs
Main breakers—Two 4,000 ampere, parallel
Connected load—8,000 kilowatts
Estimated demand—4,035 kilowatts
Air conditioning—1,000 tons (two 500-ton units)
Ninety kilowatts of lighting per floor
Eighty-seven kilowatts resistance heating per floor
Total electric load—23 watts per square foot in office areas



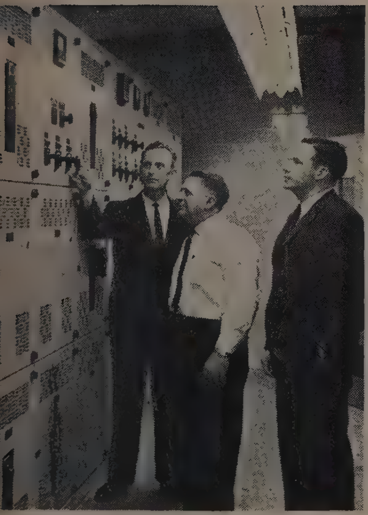
C. A. Alexander, Architect, and Earl Blakely, Consulting Engineer, shown in the handsome lobby of the Georgia Power Headquarters office building. Lobby was designed to showcase mechanical and electrical equipment and stress the importance of electrical services in modern office building operation. Westinghouse motor control center at right groups combination starting units into one structure affording flexibility, accessibility and safety. Modular construction features tilt-out design to isolate starters from bus for extreme safety in maintenance and inspection. This motor control center controls and protects mechanical room pump and fan motors.



J. E. Chambers; O. U. Moore, Jr., Contractor Job Superintendent; and Earl Blakely, discussing a Westinghouse motor starter panel. Two such panels are located on each of the building's 22 floors to control supplementary perimeter heaters. New motor starter panels afford grouping when a small number of circuits are to be controlled. Low-impedance bus duct runs at rear feed electric heating. Bolt on power take-off devices limit high fault currents available in the system, protecting all electrical devices.

Discussing the low case temperature of
300 KVA type DT-3 dry-type transform
are J. W. Tysinger, Westinghouse Sal
Engineer; T. E. Luther, Building Supe
intendent and Earl Blakely. Silicone insu
lation in this class H (150°C) transforme
offers greater resistance to heat . . . pr
vides a greater range of safety for ove
loads . . . thus prolongs transformer lif
This transformer steps 480 volts down
120/208 wye for distribution. Westinghou
convertible type CDP panelboard at le
contains De-ion® circuit breakers for pos
tive protection against short circuits an
over-loads.

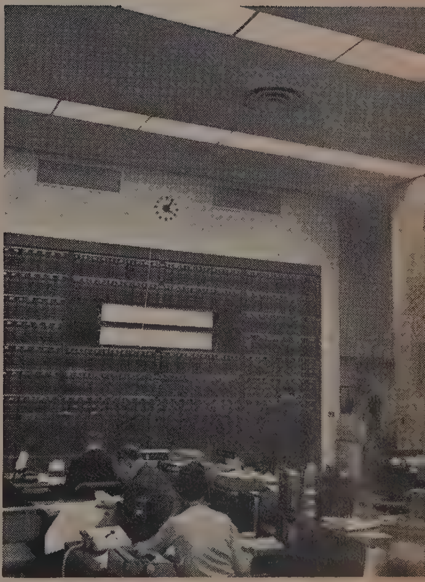
Top view of low-voltage switchgear show
two runs of 4,000-ampere low-impedan
bus duct handling incoming power an
nine 800- to 1600-ampere feeder runs. S
of these runs serve as vertical rise feede
that carry full power to all building load
Bus duct was specified for its flexibility f
future load growth additions . . . also, bu
duct has a lower installed cost than cab
or conduit. A high degree of coordinatio
was necessary on this job to insure equi
ment match-up. Westinghouse provide
this coordination in a complete line
quality equipment.



rl Blakely, T. E. Luther and J. R.
ller, Westinghouse Construction Engi-
er, discuss metering on main assembly
metal-enclosed low-voltage draw-out
tchgear. Incoming power is fed into two
in DB 100 air circuit breakers. Electri-
ly operated DB-50 breakers serve as
ders and another is used as a tie breaker
that entire board may remain energized
ring emergency. Current limiting fuses
mounted in series with all breakers to
tect against high fault currents avail-
e. Westinghouse DB breakers were spe-
ed, since so much of the building load
ed from each breaker that dependable
vice from a heavy-duty breaker is an
olute requirement.

J. E. Chambers, Vice President, Bagby Elevator & Electric Co., and H. H. Cook, WESCO, inspect a Westinghouse Life-Line combination starter. A convenient start-stop button is mounted in the cover of this size 1 Class 11-206 combination starter designed for across-the-line voltage starting. A type AB-I 100 ampere circuit breaker is mounted at right. This breaker utilizes the De-ion principle of arc extinction which stretches and extinguishes an arc faster, with less contact temperature rise than any known system.

Building: 270 Peachtree Building, Headquarters for Georgia Power Company.
Owner: Henry C. Beck, Jr and Joe B. Hutchison, Atlanta, Ga.
Architect: Finch, Alexander, Barnes, Rothschild & Paschal, Atlanta, Ga.
Consulting Electrical Engineer: Thomas E. Blakely, Associates, Atlanta, Ga.
General Contractor: Henry C. Beck Co., Atlanta, Ga. and Dallas, Texas.
Electrical Contractor: Bagby Elevator & Electric Co., Atlanta, Ga.
Westinghouse Distributor: Wesco-Atlanta.



Lobby floor office area of Merrill, Lynch, Pierce, Fenner and Smith, comfortably illuminated by 2′ x 4′ Westinghouse Mainliner fluorescent fixtures. Mainliners are available in a variety of sizes and mounting arrangements with a full line of shielding media for complete flexibility. In this installation Owens Corning Polarizing Panel shielding was utilized to eliminate glare on the automatic stock board.

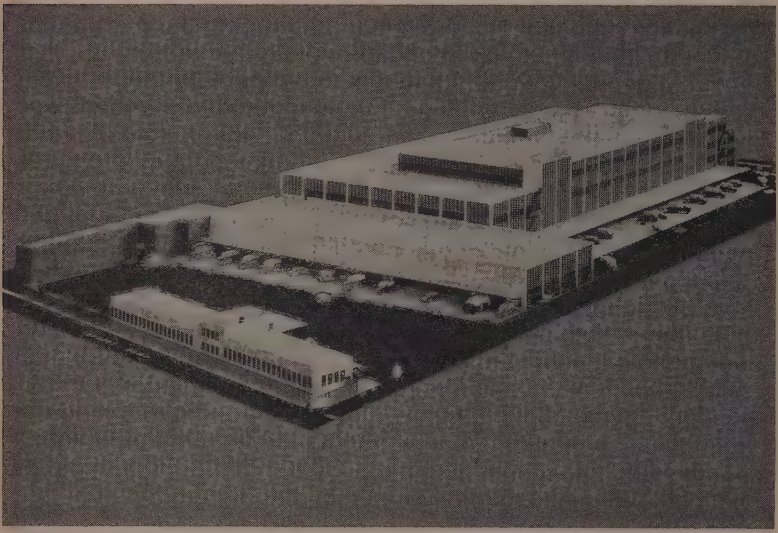
You can be sure . . . if it's

Westinghouse

J-94172

MEARS low-voltage circuit breakers . . .

Designed for
modern Public Buildings



Portland, Oregon's new $10 million multi-purpose public building scheduled for completion in 1962 is being equipped with MEARS trouble-free FUSED CIRCUIT BREAKERS. **Architect:** Stanton, Boles, Maguire & Church, Portland, Oregon. **General Contractors:** Anderson-Westfall Co., Inc., Portland, Oregon. **Electrical Contractor:** Watco Electric Co., Portland, Oregon. **Consulting Electrical Engineer:** Grant Kelley & Associates, Portland, Oregon. **Mears Representative:** H. G. Lehl, Oswego, Oregon.

**MEARS FUSED CIRCUIT BREAKERS
GUARANTEE RELIABLE POWER PROTECTION**

Specifications on this $10 million installation called for breakers that would meet the high interrupting requirements . . . economically . . . compactly. Mears fused breakers were specified because of their high interrupting capacity . . . guaranteeing complete and reliable power protection in a very compact unit.

MEARS–ENGINEERED AND TESTED FOR RELIABILITY

For example, in a recent test, a 1600 ampere fused breaker closed successfully against a 170,000 ampere fault. All Mears air or fused circuit breakers are completely tested to give safe performance margins above standard NEMA test requirements.

Other MEARS-ENGINEERED features include a variety of frame sizes from 600 through 4,000 amperes, and a variety of construction types . . . FIXED, PLUG-IN, and DRAWOUT mountings.

See the **"MAN FROM MEARS"** in your area . . . or write department EC-7 for our new Circuit Breaker Catalog.

MEARS CONTROLS *Inc.*
13725 S. W. Millikan Way • Beaverton, Oregon

posed amendments to the 1953 Code were under consideration. At that time, the location of the service disconnecting means was covered by Section 2351-a. The proposal and the action taken is recorded as follows:

Proposal: IAEI — NW Sec. — C. L. Smith, 1/3/55. Add a new sentence to read: "Cabinets, cutout boxes and similar equipment shall not be installed in clothes closets, lavatories, cupboards, fuel bins or over sinks or in similar places."

Supporting Comment: The installation of this equipment in such locations in many cases does not make them readily accessible to the owner, inspector or others who may have to inspect or service such equipment.

Panel Recommendation: No action.

Panel Comment: The present text which requires "readily accessible" has been the only one found to serve the purpose generally. Fine qualifications will not suit one area as they do another.

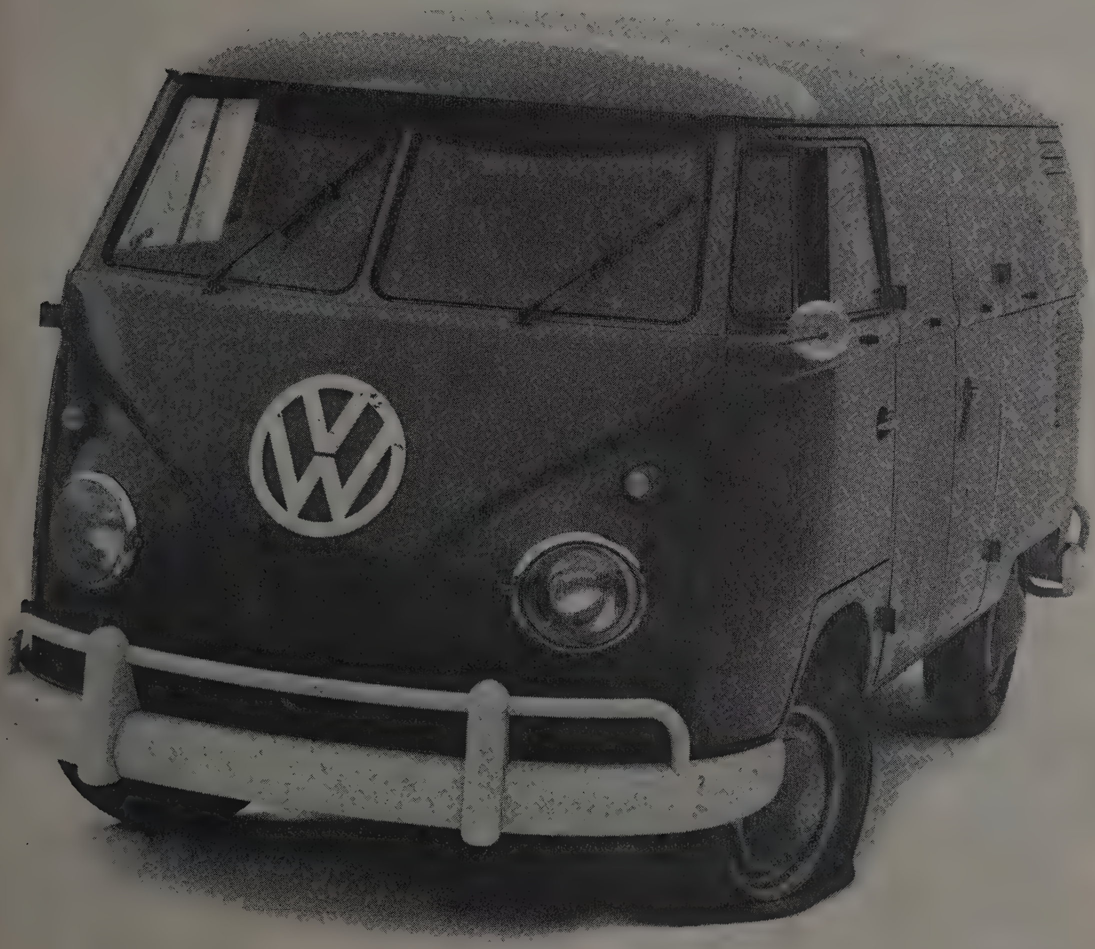
The proposal was rejected.

When the utility meter is located immediately adjacent to the service equipment inside a building, some utilities are concerned as evidenced by the following provision, quoted from the "Requirements for the Installation of Electric Services and Meters," of a utility who is concerned with the problem presented:

"It (the meter) shall not be installed where subject to vibration, excessive dampness or mechanical injury, nor on a stairway, in a coal bin, fruit cellar, bathroom, toilet, bedroom, attic, store window, back of shelving, near moving machinery, or in similar inconvenient or dangerous locations, and as much clearance as reasonable and possible shall be provided from gas meters, piping and metal ductways."

This utility requirement is based on a background of actual field experience over a period of many years, which indicated that the indiscriminate location of meters could result in fire and personal injury hazards, and a hardship on the utility responsible for servicing and reading such meters.

The foregoing utility concept of the hazard involved with a meter location also concerns, to some degree, service equipment and its accessories such as the branch circuits serving the premises. A bathroom, provided with a shower may be classified as a damp location, or possibly a wet location when the steam vaporizes and forms globules



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35,000 milesssssssssssssssssssss.

This flat's a year late.

Most trucks would have had it 15,000 miles ago.

Not ours.

Volkswagen trucks put almost a ton less load on tires. Even though they carry more than most others.

(Did we ever tell you how we took off weight?)

First, our aluminum magnesium engine is the lightest of its kind in the world.

Second, our trucks are welded together. No bolts. (This is where our strength comes from.)

There are 13,000 automatic welds in every VW truck body. It's a solid hunk of steel. This got rid of the heavy members that bolted trucks need. Like the frame.

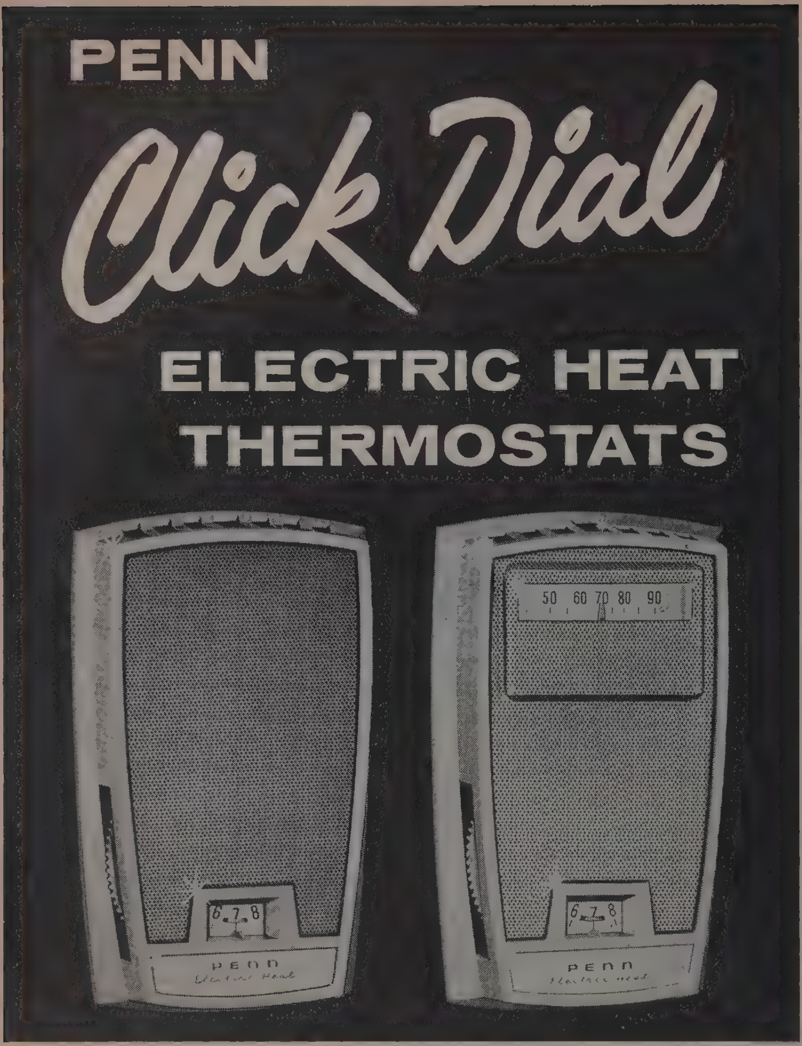
Third, no radiator, no driveshaft, no hood, no fenders. A loaded Volkswagen is as light on its tires as most other trucks empty.

Even our rear engine saves tread. The cargo rides in the middle. The tires share the load equally.

We tell owners to expect about 35,000 miles on a set, normal driving. One set of tires on a Volkswagen lasts almost as long as two on other trucks.

Some owners say they get 40,000.

Others think this is a lot of hot air.



Take your choice...you and your customers will like either one!

Whether you choose the model with or without the built-in, bimetallic thermometer, *you'll like* this thermostat because it's easier and faster to install . . . *your customer will like it* because it has extra convenience in setting temperatures accurately . . . each "click" of its large dial is a change of 1°.

You'll both like it because it responds faster to temperature changes, holds temperature closely to selected level, and has the dependable performance that results in complete satisfaction.

Slim flat front with no protrusions, the Series 800 thermostat extends only 13/16" from the wall. Its modern styling blends in perfectly with any room decor. Get the full story, write for free Bulletin.

PENN CONTROLS, INC. Goshen, Indiana
EXPORT DIVISION: 27 E. 38th ST., NEW YORK, N.Y.
AUTOMATIC CONTROLS FOR HEATING, REFRIGERATION, AIR CONDITIONING, APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES

MEDALLION HOME LIVE BETTER ELECTRICALLY

of water on ceilings, walls and other surfaces. Under such circumstances, ordinary electrical equipment enclosures are not sufficient to withstand such an exposure.

According to your diagram, we have a lavatory, which does not include a shower or bathtub. The service equipment, consisting of a 100-amp circuit breaker, and I assume the branch-circuit circuit breakers, are located above the water closet. Assuming that the breakers are readily accessible, as defined by the code, there is no code violation involved. The installation may not satisfy the utility requirements or many local codes. To me, it is an eyesore that reflects on our electrical wiring designs and the builder who does not provide suitable space to satisfy the owner's desires.—B.A.McD.—7/61/2

Surface Metal Raceway

Q. *Are fiber bushings required on all surface metal raceway installations where the raceway enters a terminal fitting?—J.A.K.*

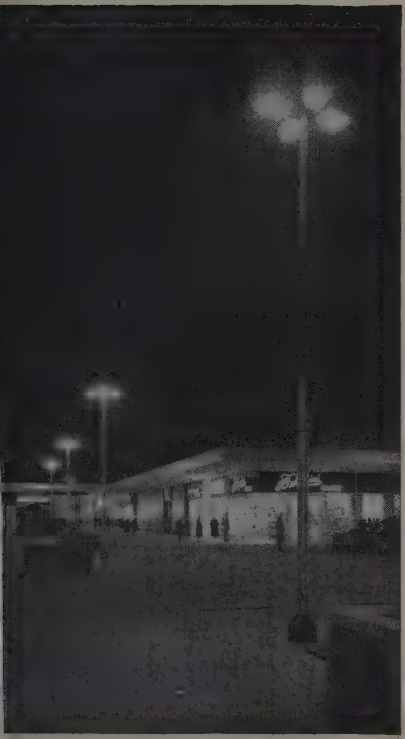
A. No. Section 352-7 covers the construction specifications of this wiring system, and it will be noted that fiber bushings are not required.—B.Z.S.—7/61/3

Emergency Lighting

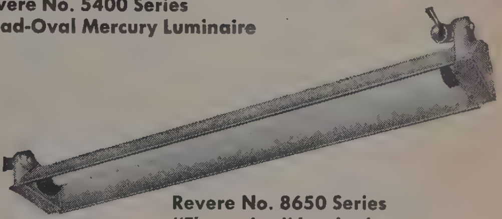
Q. *Is emergency lighting required in a mercantile establishment having a 65,000 sq ft floor area, one-story, masonry construction, with the entire area in one large room? If so, what amount of lighting is required for the area on the emergency system, and is the amount of such lighting covered in the NEC?—W.S.*

A. The question raised is covered in at least two NFPA publications: one being NFPA No. 101—Building Exits Code; the other, the National Electrical Code. Article 700, Chapter 7, under 700-1, Scope, states in part: "The provisions of this Article apply to installation, operation and maintenance of circuits, systems and equipment . . . where such systems or circuits are legally required by municipal, state, federal or other codes, or by any governmental agency having jurisdiction." You will note from the above that the provisions of Article 700 cover such emergency systems when

Revere No. 4200 Series Floodlight



Revere No. 5400 Series Quad-Oval Mercury Luminaire



Revere No. 8650 Series "Fluoresign" Luminaire

Widest line of fixtures lets you light every outdoor area the one best way for each job

You can plan each industrial, commercial, or transportation area outdoor lighting application the one *best* way for the job at hand and get *all* the fixtures, poles and accessories required from one source — your Revere wholesaler.

Ordering all components from your Revere wholesaler takes the "headaches" out of ordering, receiving and installing. Revere has exactly the fixtures you want, with matched components engineered for easy installation, peak lighting efficiency and best appearance.

Revere offers the widest line of fixtures in the industry for all types of outdoor lighting applications. You can select hinged or rigid poles . . . mercury, incandescent or fluorescent luminaires . . . floodlights, fixtures and fittings — whatever is called for to do the job the one best way.

Let your Revere wholesaler show you how Revere equipment eliminates the problems in outfitting your installations. Write to us for Revere's complete catalog of outdoor lighting equipment.

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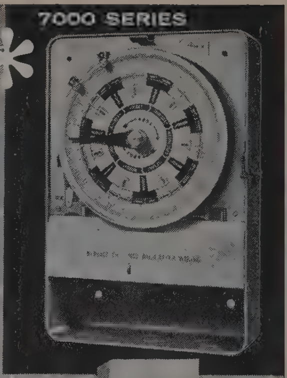

PUZZLED about Time Controls?

PARAGON
ALWAYS
CONTROLS

specify PARAGON to solve any timing problem

* 7-DAY TIME CONTROL WITH 4-POLE SWITCH... ALLOWS A WEEKLY SCHEDULE WITH INDIVIDUAL DAILY SETTINGS...ANY DAY OR DAYS CAN BE OMITTED

Here's another important development by PARAGON. It's the automatic MULTI-PURPOSE, 7-day Time Control with 4-pole switch . . . each pole isolated for 40-amp capacity.

This 7000 Series Paragon Time Control allows a weekly schedule with daily settings . . . turns ON and OFF automatically at different hours each day . . . easy to set a week in advance and changed as desired . . . any day or days can be omitted, It's the ideal control for heating, ventilating and air-conditioning in schools, public buildings, offices and factories.

Two outstanding design features include:

- FOUR-POLE, 40 AMP RATING...Controls four different voltages. Each switching contact is completely isolated. This design allows the same switch to do the work of all the various 7-day controls available in the industry.
- EASY INSTALLATION...Ample wiring, gutter space... convenient knockouts—large terminal screws.

For fast delivery . . . complete details on any Paragon Time Control . . . location of Service Center . . . contact your authorized Paragon Distributor. He carries a full line in stock, and is highly qualified to offer technical assistance on any application.

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1614 TWELFTH STREET • TWO RIVERS, WISCONSIN

LEGALLY REQUIRED, and express HOW to install such systems WHEN they are required.

In the Building Exits Code you will find mercantile establishments listed by three classifications owing to the size of the building. Class A is one having a gross floor space area of 30,000 or more square feet, which would correspond to the size building in your question. A building of this classification is required to have emergency lighting facilities. The amount of lighting required for the emergency system is not given in the Building Exits Code except as follows:

"5201. All exits and the necessary ways of approach thereto shall be illuminated to facilitate egress. Such illumination shall be continuous during the time that the conditions of occupancy require that the exit ways be open or available. Artificial lighting shall be employed at such places and for such periods of time as required to maintain the illumination to the full footcandle values herein specified."

"5202. The floors of exit ways of buildings used for public assembly or congregation, schools, department stores, factories, mills and other occupancies as required by Chapter II shall be illuminated at all points such as angles and intersections of corridors and passageways, stairways, landings of stairs and exit doorways to values of not less than 1.0 footcandle measured at the floor."

In the same publication there is a fine print note as follows: "For further information on illumination, see the following standards of the Illuminating Engineering Society:

"American Standard Practice for Industrial Lighting.

"American Standard Practice for School Lighting.

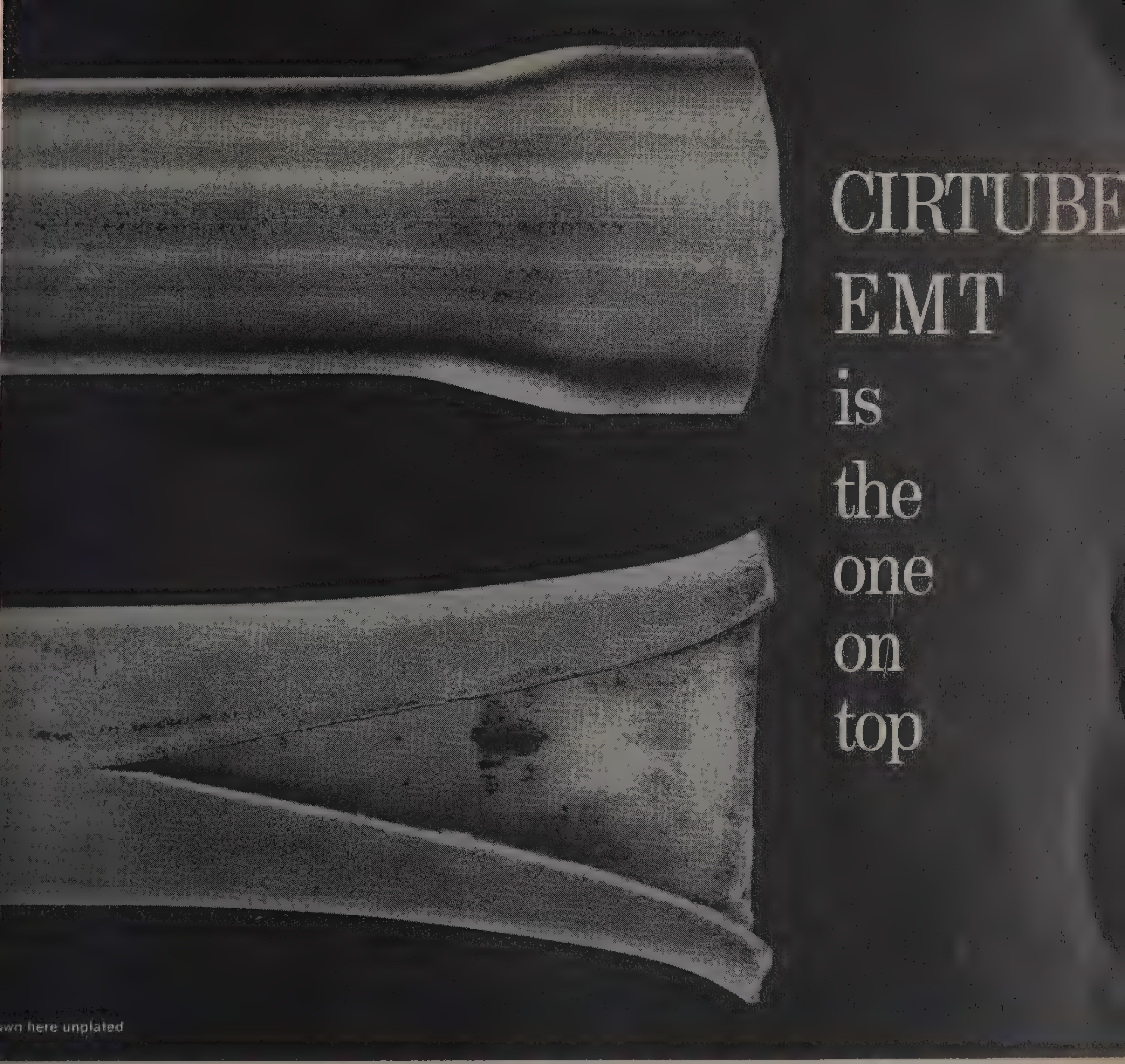
"Recommended Practice for Office Lighting.

"Lighting Practice for Stores and Other Merchandising Areas."

Article 700 of the NEC concerns Emergency Systems. Section 700-14, concerning your question, reads as follows:

"Emergency Illumination. Emergency illumination shall include all required exit lights and all other lights specified as necessary to provide sufficient illumination.

"Emergency lighting systems should be so designed and installed that the failure of any individual lighting element, such as the burning out of a light bulb, cannot leave any space in total darkness."—R.E.W.—7/61/4



The other one is ordinary EMT that failed early in a pressure test. CIRTUBE EMT held up far beyond UL requirements. The reason: *continuous induction welding*, by far the best technique for making *bead-free, split-free* welds on high quality EMT.

The benefit: your men get easier, neater bending without kinking or flattening—and they get it right the first time around. Add easy fishing, a good-looking, life-time finish, easy-handling bundles and fast, friendly service—and you'll know why more and more contractors are specifying CIRTUBE EMT.

Ask for it on your next job—you'll like working with it.

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PLANTS: Maspeth and Hicksville, N. Y. **SALES OFFICES & WAREHOUSES:** In all principal cities.
Rubber Covered Wires & Cables • Varnished Cambric Cables • Plastic Insulated Cables • Neoprene Sheathed Cables • "CIRTUBE" EMT

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Patients look better, feel better and see "Decidedly Better" with

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NEW HOSPITAL BED LIGHT BY DAY-BRITE

What a difference TRANQUILITE makes! New hospital rooms become less clinical looking, more inviting. In older rooms, defects seem to disappear under TRANQUILITE's soft illumination.

Cleartex® type panels reduce glare, making TRANQUILITE ideal for multiple-patient rooms. Switching provides general illumination, reading light and night light. A handy outlet is provided for examining lights, electric razor or radio.

TRANQUILITE is available in 2- or 4-foot lengths, in stainless steel or baked white enamel finish. For additional information, contact your Day-Brite representative, or write: **Day-Brite Lighting, Inc., 6260 N. Broadway, St. Louis 15, Mo., and Santa Clara, Calif. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ont.**

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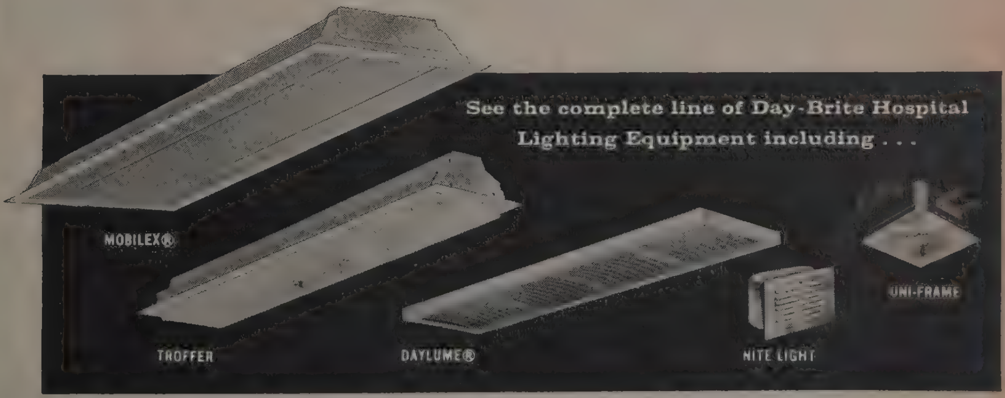
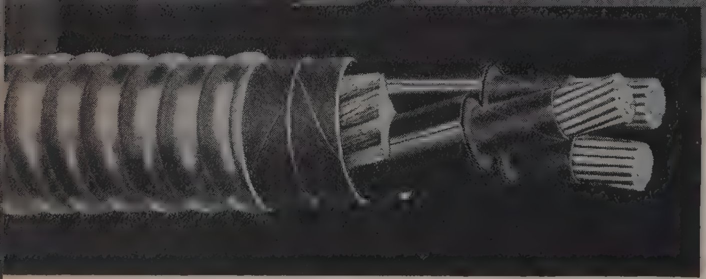
NATION'S LARGEST MANUFACTURER OF COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT



See the complete line of Day-Brite Hospital Lighting Equipment including . . .

EASILY HANDLED—Neat, compact arrangement of 2300-volt power feeders shows how easily Loxarmor cables are handled. These circuits serve a new 15,000 kva "packaged" substation.



A LOOK INSIDE—This cut-away shows details of the quality construction that is part of every Loxarmor cable. An additional advantage is available in an Okoseal (polyvinylcholoride) jacket which can be supplied over and under the Loxarmor where environmental conditions warrant.

LOXARMOR®—the interlocked cable that bends itself to your will

You're the boss when you specify Loxarmor, Okonite's interlocked armor cable. Whether you require galvanized steel, aluminum, bronze or copper protection, Loxarmor is manufactured to your specifications. And Loxarmor cables are easily handled at both vertical and horizontal bends, as well as in crowded locations where circuits must be bent around piping and other apparatus.

Because of its installation economies, Loxarmor is finding increasing use in primary and secondary feeders, power and lighting circuits, station auxiliaries, control circuits, and motor circuits in place of rigid conduit systems.

Here are a few of the many advantages of Okonite Loxarmor cables:

Lower material and installation costs save money . . . additional circuits are easily added . . . circuits are easily rerouted . . . accessibility of Loxarmor reduces downtime . . . flexible, compact construction reduces space requirements. And the strict quality control under which Loxarmor is made, contributes to its continued record of superior service in the field. It all adds up to Okonite Cable'bility* —the ability to design and manufacture electrical cables that give outstanding performance.

To learn more about Loxarmor write for Bulletin EC-1090. The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, N. J.

*Cable'bility . . . cable craftsmanship since 1878

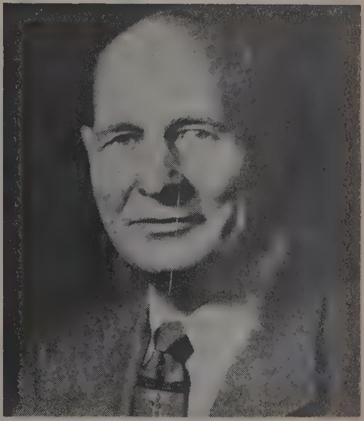
OKONITE PASSAIC, N.J.

where there's electrical power . . . there's **OKONITE CABLE**

In the News

28th EASA Convention Reports Upward Trends

George Larsen of Los Angeles elected to lead 1600-member Association as delegates to San Francisco meeting analyse customer relations, sales promotion ideas, practical shop methods and opportunities for greater service.



GEORGE LARSEN, vice president of Larsen-Hogue Electric Co., Los Angeles, was installed as 27th president of EASA.

The Electrical Apparatus Service Association (formerly NISA) held its 28th annual convention in San Francisco during the week of June 11th, with over 750 members and guests actively participating in well-attended technical sessions, practical "working" forums, exhibition-related discussions pertaining to shop equipment and products, plus visitations to local repair shops. Delegates also had the opportunity to officially welcome president-elect George Larsen, Larsen-Hogue Electric Co., Los Angeles; and recently appointed executive vice president August A. Baechle. Attention was likewise focussed upon outgoing president J. Arthur Turner Jr., Tampa Armature Wks., Tampa, Fla., who was presented with a gold pickaxe (symbolic of his efforts in EASA's behalf as well as of California's Era of Gold) by Convention Chairman John S. Van Alstyne, Sacramento.

GOLDEN PICKAXE was presented to outgoing EASA president J. Arthur Turner, Tampa, Fla., by Convention Chairman Jack Van Alystyne, Sacramento, Calif.

As at all former national meetings, primary attention was directed to production methods and equipment designed to improve operational efficiency in shops of EASA members, this category being discussed by Walter G. Brush, Electric Motor Service, Birmingham, Ala.; John C. Reed, Reed Electric Co., Portland, Ore.; Frederrick McBroom, McBroom Electric Co., Indianapolis, Ind., and by T. R. Warriner, Warriner Hermetics, Fort Worth, Texas.

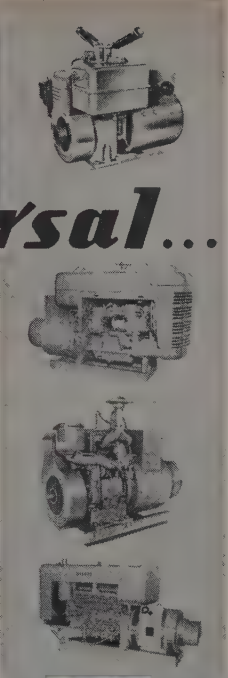
Shop Methods Reviewed

Confining his remarks to shop methods related to large and medium sized motor repairs, Brush discussed desirable equipment for a new shop, using numerous slides to illustrate such items as impact tools and stripping tongs, vapor degreasing tanks and check-list accounting forms, electric hoists and large truck entrances, walk-in ovens and spray paint booths, steam cleaning units and dynamic balancers, modern coil winders and spreaders, air compressors and test panels.

Reed's remarks concerned establishing new business in competition with large manufacturers, maintaining that success depended upon the shop's general attitudes and policy, price schedule, service, quality of workmanship, engineering and sales efforts, plus over-all reputation. Reed stated that customer relations could be furthered by honesty, honoring warrantees, inviting shop visitations, and keeping customers informed of new equipment and methods being used to insure quality work.

Shops handling small motors were analyzed by McBroom, who reviewed departments concentrating on single- or 3-phase motors, power tools or specialty devices. In this review, McBroom emphasized importance of extensive inventories of replacement parts, special tools for insuring shop efficiencies, modern equipment and practical floor layouts, test panels and metering devices. Paying tribute to general excellence of shop equipment on the market, he urged delegates to "never build an item you can buy," then drew applause when he added that "having a personal interest in a business seems to improve a man's efficiency, industry and memory."

Warriner's talk cited a tremendous repair potential pertaining to hermetically sealed motors and compressors, stating that his own shop was designed to handle 200



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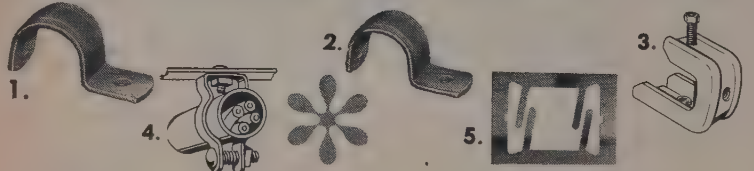

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Blackhawk's **HOLDING AND FASTENING FITTINGS**

1. Snap-Strap Rigid Conduit — 700. The original snap on clamp that snaps tighter and holds its grip. Sizes: 3/8" to 2"

2. Snap-Strap for Thinwall Conduit — 1700. Same style as 700 line, except they are made to fit Thinwall conduit. Sizes: 1/2" to 2"

3. Beam Clamp. Complete with case hardened set screw. Fits up to 1/2" thick beam flange. 1/4-20 tapped holes.

4. Conduit Hanger. Designed to hold thinwall and rigid conduit. 1/4" hole in the base permits use with toggle bolt, wood screw or anchor. Complete line of sizes.

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John C. Reed, Reed Electric Co., Portland, Ore.

compressors a day, and that a complete repair cycle of four hours per unit could be achieved through adoption of production-line routines pertaining to cleaning, winding, painting and assembly. Warriner stated that compressor business in the south was influenced by seasonal refrigeration and air conditioning, and also stressed the role that repair shops play in handling repairs for compressor assembly firms during the latter part of normal 5-year warranty periods, after the usual 20-month guarantee of parts by manufacturers has expired. Concluding by referring to possible repair pitfalls and experience-backed practical methods used in his shop, Warriner generously offered to "open my shop and my books" to any EASA member who would like to investigate this repair field more thoroughly before entering it.

Customer Relations

Another practical discussion was contributed by Charles W. Doane, sales manager for Larsen-Hogue, Los Angeles, who related how his company had promoted customer relations. Mentioning that reputations for integrity and dependability demand constant attention by all personnel in an organization, he cited numerous examples indicating how favorable (or adverse) impressions had been created by individual actions or statements of shop employees ranging from presidents to telephone girls, shipping clerks, truck drivers and shop foremen. Using the catch-phrase of "the ACID test," Doane summarized by saying that good customer relations depends upon all personnel circulating in various groups to strengthen a company's reputation for integrity and dependability.

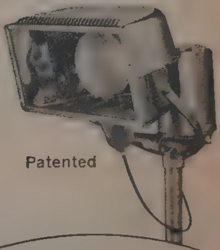
The potential value of seminars at management level was the subject of a talk by Stephen Vasquez, Dean of St. Louis University's

You've got to grab it at both ends!

As you can see, the mercury vapor lamp used in floodlights is pretty big. Its Mogul base is very small by comparison. And it doesn't provide full support. So if you just screw one into a socket like you would a bulb in a floor lamp, you shouldn't be surprised if it breaks when the floodlight gets jolted around.

But when you grip the lamp at *both* ends, the way the lamp is held in a Wide-Lite, it can shrug off jarring and vibration. One contractor, for example, has put Wide-Lites on skid-mounted towers and tows them by bulldozer across his rugged construction site. He hasn't had a lamp break since the job began 18 months ago! The Stabilux socket, which grips the lamp at its upper end and makes such durability possible, is found *only* in Wide-Lites. It is patented. And it is one of many such features that make Wide-Lites so provably better.

Send for the full story, and judge for yourself. Write today! Wide-Lite Corporation, Dept. PA 111, 4114 Gulf Freeway, Houston 1, Texas.



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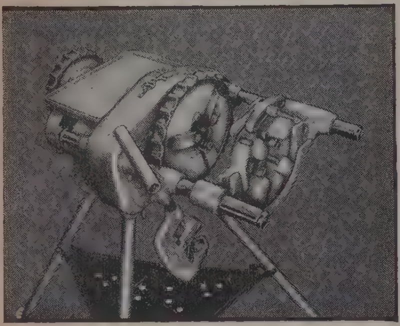

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Quick-opening die heads for threading ½″ through 2″ pipe or conduit. Fits into Nye saddle — perfect alignment —

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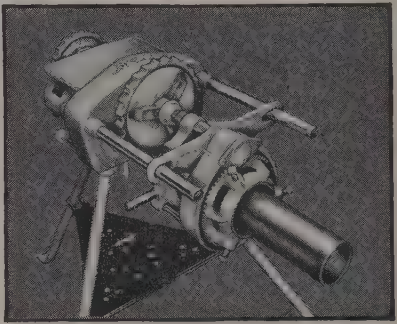

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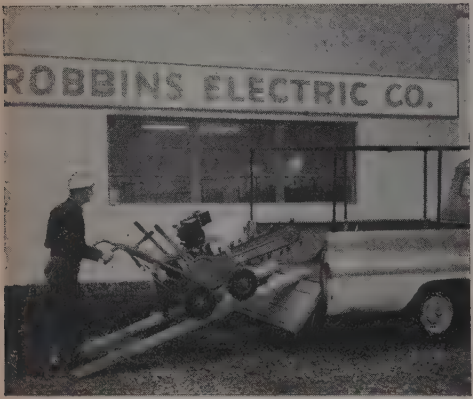

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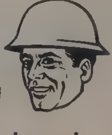

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Fast trenching at lowest cost. Reduces man-hours to minutes. Eliminates disadvantages of subcontracting. A profitable, inexpensive machine to own and operate.

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- Light weight, compact, portable
- Since 1956 satisfied users all over U. S. A.
- Dependable trouble-free trenching at lowest cost.
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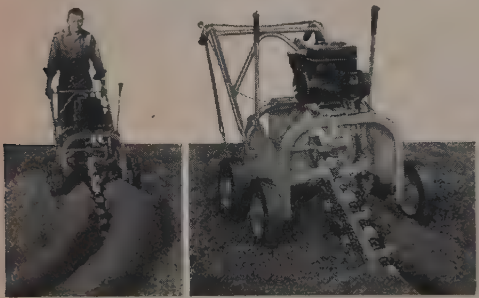
ELECTRICAL CONTRACTORS USE POW-R-SPADE to lay cable and conduit. Savings and extra profits on every job. Have your own machine. No waiting. No delays.



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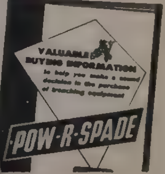
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Ken Yee, Ken's Electric Service Honolulu.

School of Commerce and Finance, who stated that management is a distinct skill involving knowledge of objectives and the ability to organize, plan, staff and control essential operations. Ability to obtain cooperation from others is a "magic touch" which has to be developed by individuals, and good management is a progressive state of "becoming" rather than obtaining a static condition. Therefore, management seminars are useful in that they increase each participant's understanding regarding problems and solutions related to personnel, sales, cost control, financing and the like. And, while it is impossible "to get individual experience from collective ignorance," it likewise is a fact that "no one is as smart as all" in a serious discussion group.

EASA's "Open Door" Praised

At the opening session, keynote speaker Fred H. Pillsbury, president of Century Elec. Co., St. Louis, Mo., paid tribute to EASA's growing membership and importance, noting that shops were constantly growing in size, numbers and diversity, demanding greater know-how and specialty equipment to diagnose and repair mushrooming series of faults related to motors, controls and system components. He also praised EASA's "open door" exchange of ideas between competitors, and acknowledged that reputations of motor manufacturers frequently depended upon customer satisfaction resulting from quality service rendered by independent

Frederrick McBroom, McBroom Electric Co., Indianapolis, Ind.

I-T-E BUILDS THE MOST USABLE FUSIBLE LOADCENTERS

Get more for your money! *Specify I-T-E!* Only I-T-E gives you rugged panelboard-type construction in a residential product . . . a model for *every* application . . . *plus separate packaging* that reduces your out-of-pocket costs and speeds installation!

Use I-T-E Fusible Loadcenters and you can buy the box separately . . . rough-it-in, and add the interior and trim later as the job progresses. All Uni-Pak boxes have a standard 14¼″ width and fit snugly between 16″ stud centers. The box almost *holds itself in place* as you secure with nails or screws to studs through quarter-inch knockouts. Get the whole story. *Write I-T-E Circuit Breaker Company, Walker Division, 125 Bennett Street, N. W., Atlanta 9, Georgia. Ask for Bulletin 561.*

New 1961 Speedfax Catalog just off the press!

Ask your I-T-E salesman for a new Speedfax catalog so you can have a handy quick reference to I-T-E products at your fingertips.

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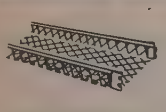
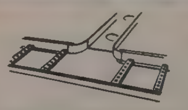
Cope Standard and Double-Capacity Underfloor Duct for conventional slab construction . . . Cope Headerduct for coordination with cellular floor construction—all three provide maximum service availability and flexibility of outlet locations to meet specific needs.

A complete line of Dreyfuss designed service fittings are readily installed with Cope Underfloor Duct Systems . . . can also be used to modernize existing systems.

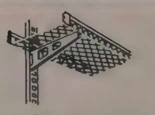
Contact your Cope man—or write direct for detailed data on Cope Underfloor Duct Systems. FORMERLY SPANG—NOW MADE BY COPE, THE LEADING MANUFACTURERS OF CABLE SUPPORTING SYSTEMS.



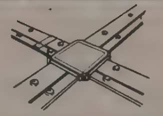
COPE WIREWAY



LADDER AND CHANNEL



SYSTEM SUPPORTS



UNDERFLOOR DUCT

COPE DIVISION ROME CABLE CORPORATION
Collegeville, Pennsylvania Dept. G

A CHOICE OF WIRE AND CABLE SUPPORTING SYSTEMS

Walter G. Brush, Electric Motor Service and Cleveland Electric Co., Birmingham, Ala.

shops such as those represented.

Significance of service shops in a manufacturer's customer-relations program likewise was cited by William M. Terry Jr., general manager of industrial electrical departments for Allis-Chalmers, Milwaukee, who stated that separate growth-and-profit interests of manufacturers, customers and service shops depended upon mutual cooperation, and that EASA could further its own over-all performance concept by relaying to manufacturers their own as well as their customers' experiences concerning product construction, weaknesses and possible improvements. He also discussed the fallacy of buying products strictly by price, since price doesn't necessarily reflect values pertaining to performance, life and similar essential characteristics.

Views of motor manufacturers also were presented by Ralph Vara, Reliance Electric and Engineering Co., Cleveland, and by William J. Wagner, General Motors' Delco Division, Dayton, who voiced the theme that motor applications were constantly expanding in industry, commerce and the home; that repair shop growth is proportionate to industry growth, and that trends toward automation are placing critical emphasis upon roles of engineers, specialists and technicians

J. J. Reddington, J. J. Reddington Service, Boston, and Frank Sweeney, Alfred L. Brown Associates, Worcester, Mass.

Lynn R. Silver, C. W. Silver Co., Salt Lake City, Utah.

responsible for reliable performance of all types of electrical systems. Wagner used slides to illustrate suggestions regarding advertising, business promotion, public relations and sales meeting techniques, while Vara showed numerous varied motor and electronic control applications, wiring arrangements and component hookups.

"To Buy Or Not To Buy"

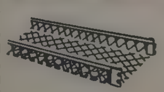
Whether to buy or not to buy new equipment was the subject of a talk by Paul Potter, Potter & Rayfield, Atlanta, Ga., who maintained that this question has critical significance for those desiring to hold their competitive positions by maintaining modern shops. He mentioned that designing and building your own equipment often has merit, and listed many specific items developed in this manner by EASA members, referring particularly to such equipment as spreaders, winders, coil cutters, and bell reamers and presses. However all do-it-yourself ideas are not economical or efficient, he stated, urging EASA members to consider buying new equipment before contemplating creation of theory-practical but untested devices. "Getting by" with old equipment isn't enough today, he continued, and "equipment be-

Dr. Henry L. Lee, Jr., Epoxylite Corp., and William H. Braunlich, Braunlich-Roessle Electric Repairs, Pittsburgh, Pa.

CABLES COULDN'T BE EASIER TO INSTALL...

Start with rugged system supports, wall-mounted or suspended from the ceiling in minutes. Then join lightweight system components quickly with just a coupler plate and two steel pins. Add sections, change direction, elevation, or width as required—Cope Wireway makes the toughest jobs easy. To pull the cables? Just lay them in the trough. One section of 24" Wireway supports as many cables as fourteen lengths of 4" conduit—ample capacity to handle the heaviest distribution loads.

Easy to work with, easy to get at, Cope Wireway makes every installation simpler, faster. Ask a Cope man about the complete line of Cope cable supporting systems—or write direct for detailed data. SOLD ONLY THROUGH AUTHORIZED ELECTRICAL WHOLESALERS.



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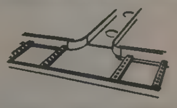
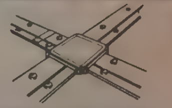


LADDER AND CHANNEL

SYSTEM SUPPORTS



UNDERFLOOR DUCT

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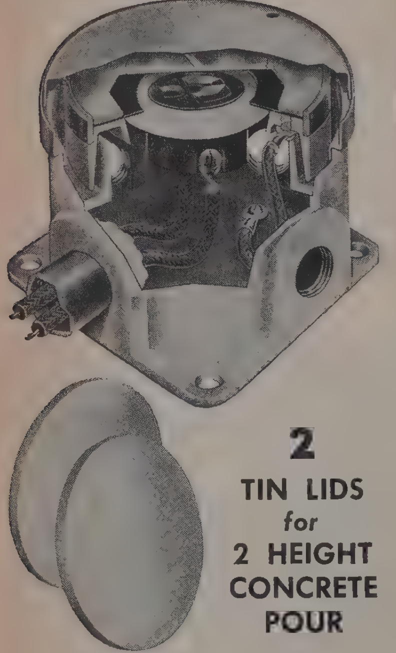
Collegeville, Pennsylvania Dept. G

A CHOICE OF WIRE AND CABLE SUPPORTING SYSTEMS

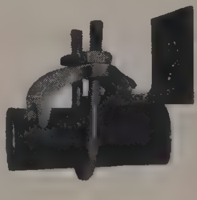
Latrobe
Electrical
Products



2
TIN LIDS
for
2 HEIGHT
CONCRETE
POUR

This Cast Iron adjustable floor box comes with 3½" or 4¼" brass cover plate and 2" abandon plug for Power or ½", ¾" or 1" for Telephone service. Equipped with ground wire.
A 2 part Tin Lid is provided for top concrete pouring. The cut-away picture above shows top adjusting section with brass cover-plate and two tin lids exposed.
The top tin lid is removed after hardening of concrete along with top adjusting section, providing easy access to wiring.
Completely fire-proof and complies with the National Electric Code. Underwriters Laboratories approved.

Pipe or Conduit Clamp



This clamp is made with a double safety bite of case hardened tool steel. Two models — Right Angle and the Parallel support. Each model comes in 11 sizes to handle pipe or conduit ⅜" thru 4".

Latrobe Products

Non-Adjustable Floor Boxes
Adjustable Floor Boxes
Gang Boxes—Cover Plates
Junction Boxes—Nozzles
Pipe or Conduit Hangers
Insulator Supports
Cable Supports—Fish Wire
Staple and Cable Clips

Fullman
Manufacturing Co.
1209-1215 JEFFERSON STREET
LATROBE, PA.

T. R. Warriner, Warriner Hermetics, Fort Worth, Texas.

comes obsolete the same day a competitor obtains a device which is more efficient." In considering new purchases, he reviewed advantages related to time payments, leasing arrangements and permissible tax deductions related thereto.

Use of practical equipment for promoting office efficiency also came in for consideration when Phil A. Reilly, Todd Co., a division of the Burroughs Corp., discussed office methods and equipment prescribed for small businesses. In this presentation, Reilly stressed importance of accuracy, speed and simplicity of records, maintaining that they reflect status of inventory and profit, and that they are essential yardsticks in analyzing faults and evaluating purchases of new equipment. Versatility of modern bookkeeping machines was demonstrated at this session, while the question of "whether to buy" was equated to such questions as whether changes of bookkeeping practices would result in reduced costs or faster payments from customers.

Behind The Scenes

These various presentations by five successful independent electrical apparatus shop executives, four officers of major electrical manufacturing firms, an equipment

Earl S. Brooks, United Electric Motors, Seattle, Wash.

1

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with
proven . . .

1. Electro-Mechanical Strength

Electro-Mechanical Strength is just one of three vital requirements for Service Entrance switches. The other two: Operating Performance and Load-Break Dependability. Specify the switch that's proven in these areas.

The Pringle LOAD BREAK Switch for Service Entrance duty was tested for these minimum standards. Electro-Mechanical Strength sample: switches closed against maximum station short circuits (130,000A. 510V.)—no damage! Another: switches were subjected to maximum station (110,000A. 610V.) for 5 full cycles—again, no damage.

See the proof yourself. Send today for the fully detailed Report on the recent series of tests. Just ask for Test Report Bulletin P-112.

Pringle ELECTRICAL MANUFACTURING COMPANY
1906 N. SIXTH ST., PHILADELPHIA 22, PA.

L. Moreland, Larsen-Hogue Electric Co., Los Angeles; Frank Silveria, Sr., Los Banos; Don G. Macruder, Electropower, Bakersfield; and Frank Silveria, Jr.

distributor, an educator and an office methods authority constituted three useful, informative, interesting programs, which were chairmanned during the 3-day meeting by Earl S. Brooks, United Electric Motors, Seattle, Wash.; Lynn R. Silver, C. W. Silver Co., Salt Lake City, Utah; and by Michael J. Kovall, Kovall Electric Motor Works, Hollywood, Calif.

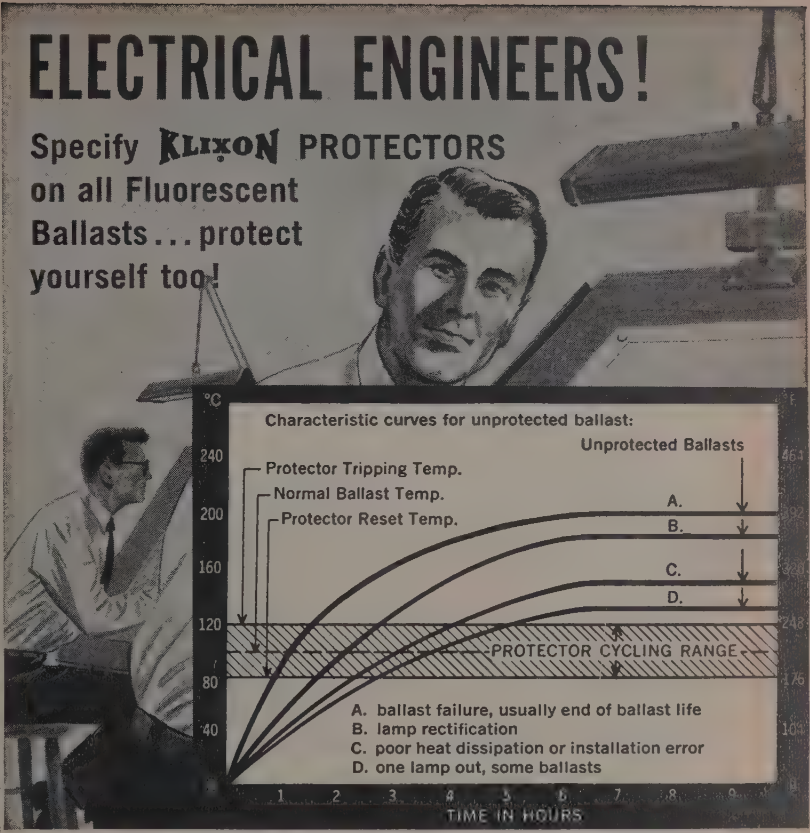
Delegates also responded enthusiastically to a succession of jam-packed afternoon "working forums" which were moderated by Frank Search, Frank's Electric Motor Co., Long Beach, Calif. (power tools); C. L. Hataway, Hataway Elec. Motor Service, Kansas City, Mo. (fractional hp motors); Warren C. Mielke, Mielke Elec. Works, Duluth, Minn. (electronics and hermetics); Joseph F. Ferrari, Excel Elec. Service Co., Chicago (layout and equipment of large motor shops); Selden High, Sullivan Elec. Co., Cincinnati, Ohio (long range planning); and Henry T. Winkleman, Tri-State Armature & Elec. Works, Memphis, Tenn. (day-to-day management problems).

Credit for conference "mechanics" goes to General Chairman Van

Edward C. Scudder and George Lockwood, Lockwood Electric Motor Service, Trenton, N. J.

ELECTRICAL ENGINEERS!

Specify KLIXON PROTECTORS on all Fluorescent Ballasts . . . protect yourself too!



In the installation and operation of fluorescent fixtures (see chart) you can protect your own reputation and give your client important extra benefits at low, low cost . . . simply SPECIFY BALLASTS WITH KLIXON PROTECTORS!

KLIXON® PROTECTORS ASSURE . . .

- Ballasts and fixtures that operate within U/L temperature limits . . . positive protection against overtemperature, overcurrent, or both.
- Cool running installations . . . rapid response against overheat allows correction while contractor is still on job.
- Maximum ballast life . . . external faults can not cause dangerous overheating. When corrected, ballast operates normally again. An internal fault signals need for ballast replacement . . . with protector keeping temperature at a safe level until this is convenient.
- No dripping compound, fires or violent failures at end of ballast life.

These KLIXON benefits are not attainable with fuse protection. Ballasts under some fault conditions draw less than full rated current, still deliver light, but may have a case temperature twice the allowable U/L limit for normal operation. Thus BALLAST OVERHEAT PROTECTION is a TEMPERATURE, not a CURRENT problem.

Ballasts equipped with KLIXON Protectors can be supplied to your fixture manufacturer by all six leading makers of ballasts. Simply use specifications shown here. Write for full engineering details.

USE THIS KLIXON PROTECTION SPECIFICATION

"Ballast shall be thermally protected against overheating by a built-in automatic reset overheat protector sensitive to both winding temperatures and current which will prevent winding temperatures from exceeding 120°C with the exception that the peak temperatures in the first few cycles may exceed this. The protector must allow the winding temperatures to reach 105°C minimum under normal conditions in a 40°C ambient without opening the circuit to the primary winding, and after opening shall not reclose above 85°C. Fixtures must be so designed that ballast coil temperatures shall not exceed the U/L limit of 105°C in a 40°C ambient."

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A CORPORATE DIVISION OF
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You Get MORE with

DOERR MOTORS

QUALITY...
Top performance and life.

APPEARANCE...
Compliments your product.

DESIGN SERVICE...
Solves toughest problems.

COOPERATION...
Even on small-lot orders.

YOUR PRODUCTS are *easier to produce . . . easier to sell . . .* with a Doerr motor as original equipment.

Got a problem? Doerr's experience with thousands of "specials" suggests quick, economical answers. Our broad background helps develop practical new designs to fit all of your requirements at lowest cost.

Also, Doerr quality construction assures full performance of your product . . . while compact, modern Doerr styling adds to appearance.

Fractional and Integral Horsepower Motors

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And motor "idea book." Get your copy of the DOERR Condensed Catalog . . . packed with useful data for designing, selecting and specifying. Please write on your company letterhead.

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Multi-Nepo offers rigid, hinged and pedestal poles, brackets, mountings, fittings and accessories.

Complete package lighting-mercury vapor lamps for building exteriors. Roof and wall mountings.

Catalog No. 600 for mercury vapor or incandescent lamps. Side or pendant mountings.

FOR RLM INDUSTRIALS

All standard RLM reflector shapes. Porcelain enamel finish. 100 to 1500 watts.

Alzak Aluminum or porcelain enamel finish for mounting on high open ceilings.

Industrial fluorescent Porcelain enamel reflector with apertures for upward component.

FOR FLOODLIGHTING

Complete new line of semi or fully enclosed aluminum floodlights for 500-1500W incandescent or 400 W mercury lamps. Watertight. Rotation stop, protractor and locking lever. Variety of mountings to cut installation time.

New Alzak Aluminum Enclosed Angle Type for pole top mounting.

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SACRAMENTO [illegible]

H. Bilieki, ReNu Electric Co., and Cecil R. Medsker, Miller-Seldon Electric, both from Detroit.

Alstyne, (program), plus committeemen William S. Bassett, Conrad Elec. Co., Oakland (entertainment); Alfred Kinney, Kinney Electric, Marysville (exhibits); Al Dutil, Enterprise Elec. Works, San Francisco (transportation); Frank Silveria, Los Banos (hospitality); and to Dick Gardiner, Electrical Specialty Co.; Tom Stahlbaum, Tri-State Supply Corp.; Al Ekdall, Insulation & Wires, Inc.; and Leo Alchimistri, Advance Carbon Co., all of San Francisco, (information). An active program for Convention Wives was arranged by Mrs. Mary Van Alstyne, Sacramento, who was assisted by cochairmen Mrs. Georgia Eickmeyer, Sausalito, and Mrs. Joan Kinney, Yuba City, all of California.

National officers installed included vice president Ben J. Horton, general manager of The Atkinson Armature Works, Pittsburgh, Kan.; secretary Thomas M. Paul, president of the Paul Electric Co., Sioux City, Iowa, and treasurer (re-elected) Alex A. Shovan, president of Industrial Electric Service, Hawthorne, N. J.

William H. Hogue and Charles W. Doane, Larsen-Hogue Electric Co., Los Angeles.

Western NECA Districts Convene in San Francisco

A tri-district convention of officers, contractor members and staff administrators representing the three most westerly regions of the National Electrical Contractors Association assembled in San Francisco in late April to jointly discuss problems affecting construction, code rulings affecting business, trends in line construction, labor relations, national sales promotion programs and opportunities related to electric modernization, maintenance, heating and lighting.

Referring to various statistical surveys and charts, J. W. Felber indicated that in spite of the widely touted "recession," total construction during the past three years (including modernization and repairs) had risen from $66- to $81-billion, and new construction had correspondingly jumped from $49- to $55-billion. Considering just the electrical contracting industry, he stated that, since 1954, total work volume had climbed 270%, from $4-billion to nearly 11; that NECA contractors had reported corresponding gains from $1.2 to $1.8 billion; and that union labor had shown payroll increased from $2 to $3 billion in this same period.

Rex Moore likewise urged greater selling effort on the part of contractors, citing business opportunities pertaining to modernization, electric heat, lighting and maintenance as specific examples.

As anchor man for this initial discussion N. D. Ferguson added that too many contractors seek only large jobs, and that many small categories of construction are characterized by less intense competition with resulting higher profits.

J. B. Foley, manager, Commercial and Industrial Sales, General Electric Co., Cleveland, discussed advances made during the past decade in lighting sources, fixture design, research and documentation, application advances and favorable public acceptance of higher lighting levels prescribed by various scientifically derived standards.

Four contractors from NECA's Inland Empire Chapter, Spokane, Wash., reviewed that division's educational efforts. These panelists included Rod Anderson of Rod's Electric, L. M. Stewart of Maxwell's, Paul L. Briggs of Briggs Electric, and R. R. Ecker of the Empire Electric Co. Moderating the panel was chapter manager Bob Wilkinson.

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IN THIS SIZE

Whether you're interested in service entrance equipment or a safety switch, you need look no farther than this newest Heinemann circuit breaker unit.

Far smaller than comparably-rated fused pull-outs, it carries a big 200-ampere load—consistently, without any allowances for ambient temperature. De-rating—or any form of temperature compensation—is simply unnecessary. The breaker is magnetically actuated; there's not a thermal element to be found. You can put this equipment next to heat lines, or inside a snow bank; it will always carry full-rated current, always trip as specified.

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Rated at 120/240V AC, two- or three-wire service, this unit is available with indoor or raintight, tamperproof outdoor enclosures. Either way, it costs less than what you are used to paying for fused equipment with 200-ampere capacity after de-rating.

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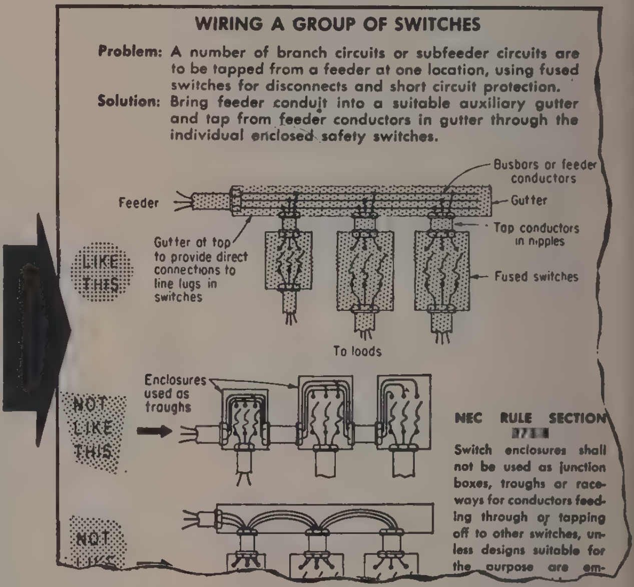

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Problem: A number of branch circuits or subfeeder circuits are to be tapped from a feeder at one location, using fused switches for disconnects and short circuit protection.

Solution: Bring feeder conduit into a suitable auxiliary gutter and tap from feeder conductors in gutter through the individual enclosed safety switches.

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Switch enclosures shall not be used as junction boxes, troughs or raceways for conductors feeding through or tapping off to other switches, unless designs suitable for the purpose are em-

Busbars or feeder conductors
Feeder
Gutter
Gutter at top to provide direct connections to line lugs in switches
Top conductors in nipples
Fused switches
LIKE THIS
To loads
Enclosures used as troughs
NOT LIKE THIS
NOT LIKE

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CONTENTS

General Considerations
Luminaires and Lighting Equipment
Motors and Controllers
Conductors
Raceways
Switches
Overcurrent Protective Devices
Switchboards and Panelboards
Transformers
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At the second session of the convention another contractor, Walter V. Anderson of Seattle, president of the Puget Sound Chapter, discussed the importance of sales promotion, stating that although few contractors are natural salesmen, they can all improve their "public image" by adopting tips, practices and procedures based upon experience and common sense.

In discussions pertaining to the National Electrical Code, conference delegates heard from two members of NECA's Committee on Codes and Standards; Sidney Hill of Hill Electric, Los Angeles, and Richard W. Osborne of Osborne Electric, St. Louis, outlining the code's purpose, methods for revision and up-coming changes in the 1962 edition.

Osborne added that the importance of the code should be reflected by the caliber of men entrusted with enforcement and inspection, and that these dedicated, qualified men should be adequately compensated by salaries comparable to the importance of their jobs. Unfortunately, he said, many local electrical ordinances have been incorporated into general building codes, with the result that general non-electrical inspectors are being entrusted with interpreting electrical rulings based upon knowledge which they do not possess, this condition frequently resulting in erroneous and inconsistent decisions.

Highlight of the second session was an off-the-record panel discussion concerning problems affecting the construction industry. In this frank exchange of opinions, A. P. Lera of Lemoge Electric presented views of contractors; moderator Richard S. Banwell and panelist Charles R. Kahrs of Reed, Rockwell, Banwell & Taries, represented architectural interests; Glenn W. Smith of Smith & Garthorne, and Thomas R. Simonson of Simonson & Simonson, spoke in behalf of electrical engineers and consultants; while Bennett L. Raffin of Rothschild, Raffin & Weirick, presented the general thinking of general contractors. Purpose of this panel was to acquaint delegates with inter-trade and inter-interest viewpoints of mutual problems.

Gordon S. Heylin discussed trends in line construction, remarking that competitive costs of contract vs. utility-crew work favored the former inasmuch as contract costs excluded indirect overhead of other departments, insurance and retirement funds.

At the fourth and final confer-

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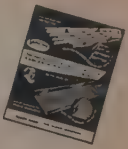

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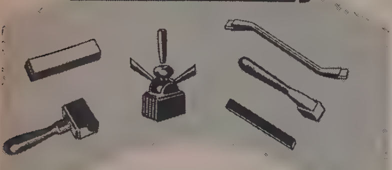

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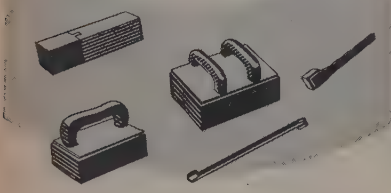

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ence session, Charles Scholibo, director of NECA's Western Region, reviewed progress in the electrical construction industry, urging contractors to demand supplemental labor agreements for such categories as motor work, electronics, telephone and special missile work, residential wiring, maintenance and modernization, and to more actively compete for contract jobs which they are now passing up.

Scholibo was followed on the program by L. Anderson and Charles Foehn, vice president, IBEW, who discussed labor relations from "the other side of the fence." Both speakers urged labor-management understanding and cooperation; joint activity in training programs and promotion activities; and regular meetings to negotiate jurisdictional problems.

Paul M. Geary, recently returned from Hawaii, then reported on electrical activity in our 50th State, indicating that NECA may soon have an Island Chapter there. He also emphasized the necessity for greater contractor-union cooperation, urging contractors to use initiative in creating broader opportunities for profitable markets.

As a final item of business it was announced that this tri-district convention will be held next year July 17-21 in Seattle, Wash.

Light Progress Evaluated at Western Regional Meetings

Indicating keen interest in lighting throughout our western states, three regional IES conferences held in Salt Lake City, Utah, Sacramento, Calif., and Harrison Hot Springs, B. C., Canada, collectively attracted over 700 members and guests. Scheduled successively to permit "circuit riders" to address more than one group, these Intermountain, South Pacific and Pacific Northwest assemblies were respectively held May 1-2, 3-5, and 8-9.

At all three meetings, national president Richard G. Slauer stated that the Society represented a forum-school combination wherein lighting progress could be recorded and taught. Above this, however, it represents a spearhead for an industry and an image for a profession, striving to provide service and leadership through research, intelligent application of knowledge, and truth in disseminating factual information.

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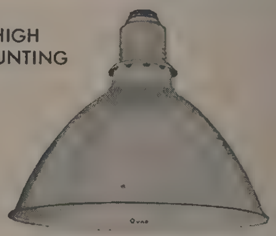

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were discussed by C. L. Crouch, IES technical director, and by A. F. Wakefield, chairman, Board of Trustees of the Research Institute, who stated that an Institute objective was to "broaden and deepen the pool of knowledge" by financially backing high-calibre researchers, and by encouraging endeavors of various technical advisory committees, such as those presently concentrating on light and vision, daylighting, predictions and conclusions.

Interior and exterior lighting practices were discussed on several programs by Robert T. Dorsey, supervisor of commercial applications for General Electric's lamp department at Cleveland. Dorsey emphasized that in an industry where new developments were constantly altering our concepts, it was essential that perspectives and application theories be similarly changed in order to equate installation approaches to progressing knowledge.

In another multiple presentation, Gene Rae, Holophane sales manager, considered modern office lighting design from viewpoints of layout, intensities, glare, environ and cost. The subject of discomfort glare was analyzed critically on several programs by Willard Allphin, Sylvania research engineer.

Another interesting presentation concerned factors affecting the efficiency of street lighting systems. As defined by Harold A. Van Dusen, Jr., development engineer for Line Material Industries, Milwaukee, ideal roadway illumination should provide even intensities over a complete roadway surface for the entire life of the lamps used.

New developments in fluorescent lamp ballasts were also considered by M. E. Robertson, manager of commercial engineering for Jefferson Electric, Bellwood, Ill.

Regional speakers at the Salt Lake conference included Walter L. Haspedis, vice president, Columbia Lighting, Spokane, Wash.; James C. Ramsey, manager, Western Regional Sales, Day-Brite Lighting, Santa Clara, Calif.; and Ariel Davis, president of the Manufacturing company of the same name, Salt Lake City.

At the Sacramento meeting, the role of Research in the realm of lighting progress was strongly evidenced. For, in addition to reports by A. F. Wakefield, IERI, and by C. L. Crouch, IES technical director, the program also included presentations by researchers Dr. H. R. Blackwell, director, Institute for Research in Vision, Ohio State University; Dr. E. M. Strong, chair-

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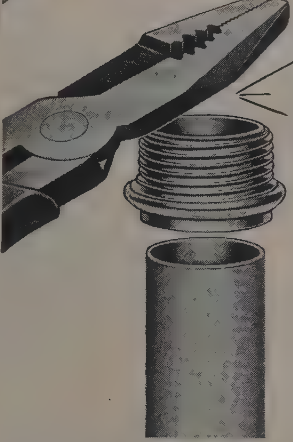

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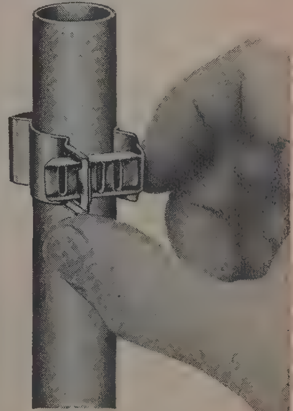

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man, Executive Comm., IERI, and professor of electrical engineering at Cornell University; Dr. Glenn Fry, director, School of Optometry, Ohio State University; John Chorlton, chairman, IES, School Lighting Committee and Supt., Building Maintenance and Operations, Toronto City Schools; and Dr. Harry Helson, IERI researcher and professor of psychology, University of Texas.

Applied Lighting

An unusually fine group of presentations distinguished the several Applied Lighting competitions, most of these entries combining unusual problems with ingenious solutions reflecting considerable understanding and use of modern equipment and approved control methods.

At the Intermountain conference, top honors in both Class I and II went to entrants from Arizona; Harold Stead of the Arizona Highway Dept., in the Commercial class for a tunnel installation; and William Keller, proxied by Bob Godeman, taking first prize in the Residential Division. Finalists in the commercial-industrial division also included Phil Smith, who won second prize for the Utah section by reviewing the new Salt Lake City airport; James Parker of Pueblo, Southern Colorado Chapter, who placed third with a church lighting project. In the Residential class, second and third prizes were respectively won by Roy R. Silver, Utah architect, and by James Watson of Denver, who served as spokesman for numerous Rocky Mountain members who had cooperated on an excellent non-commercial exhibit in a recent garden show. Judges for this contest included A. F. Wakefield, C. L. Crouch and Willard Allphin. The competition was under the direction of contest chairman Sigurd A. Blomquist.

At the South Pacific meeting, applied lighting winners in the Commercial-Industrial Class included Hunter Lauer, Diablo Section, first; William Jones, Southern California Section, second, and Bruc Thyberg, San Diego Section, third. Corresponding awards in the Residential contest were won by Peter Darnton, San Jose Chapter; R. L. Sawyier, Golden Gate Section; and Norman Tyler, Southern California Section. This contest, presented in twin sessions, was presided over by C. M. J. Wood of Golden Gate, and Henry Hampton of the Mother Lode Section. Presentation of awards was made by Regional Vice President Roy Kreyser.

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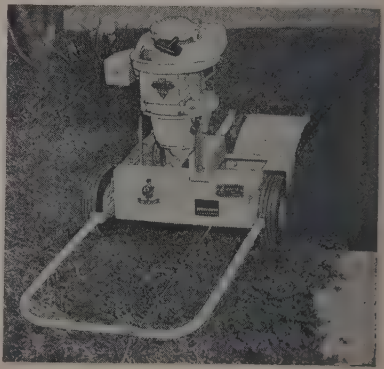

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REGIONAL IES OFFICERS at Intermountain Conference included Lloyd S. Reed of Denver and Bob Godeman of Phoenix, outgoing and incoming vice presidents.

FAEC Adopts New Trade Show Policy

The Florida Association of Electrical Contractors has announced a new policy regarding its annual conventions and annual electrical trade shows. This new policy has been adopted after long and detailed study and planning of its annual events by the Association's president, board of directors, policy committee and electrical trade show committee. Beginning this year, the annual electrical trade shows, which have in the past been held simultaneously with the Association's annual conventions, will be discontinued.

A new approach to the handling of these two major events will now be followed, FAEC has announced. This year, the 1961 annual convention will be held as usual, which will embrace a carefully planned program of profitable events for three days, for FAEC members only. This convention will be held in the Fort Harrison Hotel, in Clearwater, Fla., September 29-30-October 1st.

The new plans call for electrical expositions to be held every other year, beginning with an electrical and electronics exposition to be held next year. The first of these new trade show events will be held in 1962, in the new Civic Auditorium in Jacksonville, on November 1-3. It will be called the FAEC Southeastern Electrical and Electronics Exposition. FAEC will not have other events planned for these three days, which might interfere with the intense product and usage studies by those attending.

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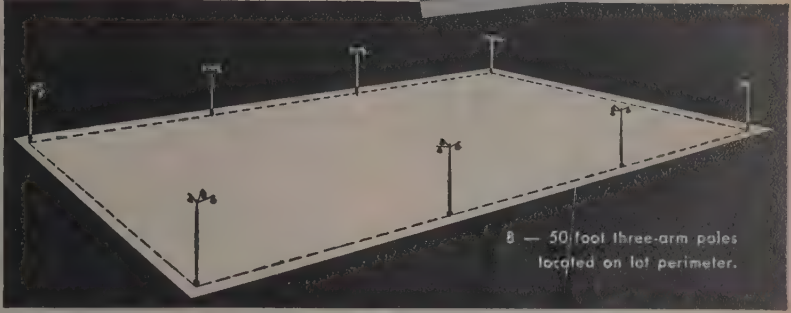

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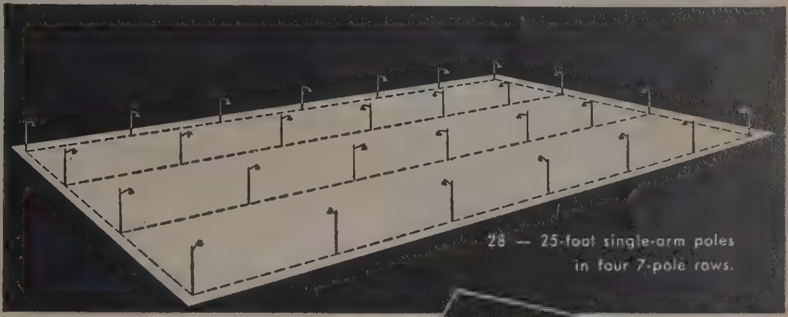

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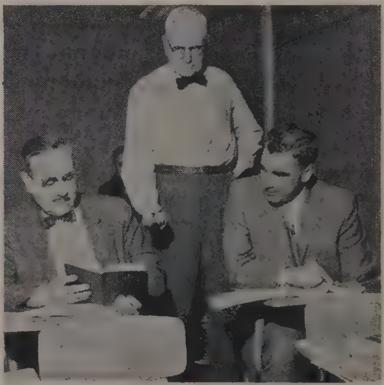
CCECA Members Brush Up On Code

For 13 weeks, some 30 members of the Cook County Electrical Contractors Association in Chicago spent two evening hours per week in a classroom at the Chicago Lighting Institute. They comprised the Code Class sponsored by the association as an integral part of its educational program. Class size was limited to about 30 persons to facilitate instruction and attention to individual questions covering all phases of the Chicago Electrical Code.

Class instructor was Roy Burgess, retired assistant-chief electrical inspector of Chicago and present CCECA code consultant. Using his 40 years of experience in the electrical construction and inspection fields, Mr. Burgess developed the course material around frequent questions, problems and interpretations that crossed his desk while in the inspection department. Basic intent, rather than specific wording, of regulations was emphasized throughout the course. Burgess worked on the premise that a contractor who knows the reasoning behind a rule is more apt to understand and remember that rule. Net result will be a better appreciation of the code, fewer mistakes and an improved contractor-inspector relationship. The need for judgment in rule interpretation permeated each session.

The logic and success of this approach was evident from the high average attendance, the interest maintained and the healthy floor discussion throughout the course.



GETTING ANSWERS to the "why" of a code rule during a break in the CCECA Code Class in Chicago are: Anton Mayer (left) and Joe Agosto (right) of Buck Electric Company. Class instructor is Roy Burgess (standing), retired assistant-chief electrical inspector of Chicago and present code consultant to Cook County Electrical Contractors Association.

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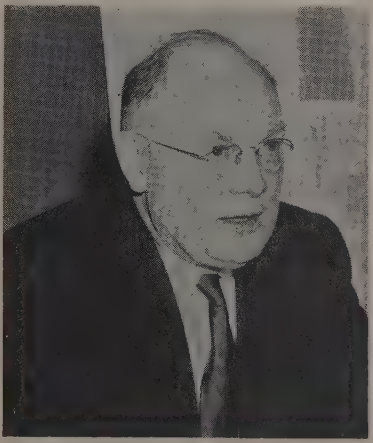
Austin Elected UL Vice President

W. S. Austin was elected vice president and secretary of Underwriters' Laboratories, Inc., at the Board of Trustees Executive Committee meeting in Chicago, May 29.

Mr. Austin joined the UL staff in New York in 1925 as an assistant to the assistant secretary-treasurer. In 1936 he transferred to Chicago, where he worked in the Label Service Department until becoming assistant to the treasurer in 1941. In 1946 he became assistant secretary and in 1947 was elected secretary.



George Andrae

George H. J. Andrae, president of the Herman Andrae Electrical Co., Milwaukee, Wis., died on June 16.

Nationally known for his work in establishing electrical codes, Mr. Andrae received the James H. McGraw Award in 1946 for his contributions as chairman of the National Electrical Contractors Association Codes and Standards Committee. In 1957 he became the first recipient of the Coggeshall Award for his part in bringing about the present system of code-making panels and the correlating committee.

He was born in Milwaukee and graduated from the University of Wisconsin with an electrical degree in 1916.

After working for years for the Westinghouse Electric Corp. in Boston and Pittsburgh, he returned to Milwaukee in 1920 and joined his father, Herman Andrae, in the family electrical business. He was the author of many articles on electrical codes and for 24 years served on the advisory committee to the State Industrial Commission.

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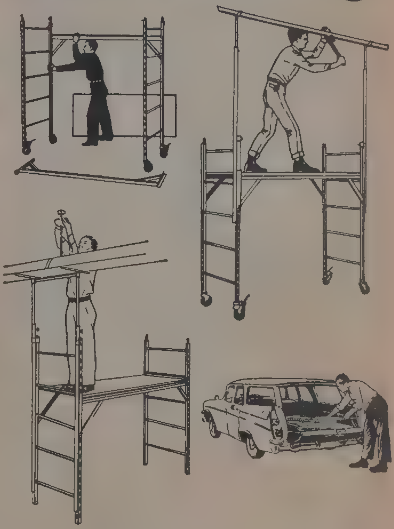

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Western Plant Maintenance Show—Pan American Auditorium, Los Angeles, Calif., July 18-20.

International Association of Electrical Inspectors — Chapter Meetings — Western New York, Lockport, N. Y., July 19; **Southern California**, Riverside, Calif., July 26; **Oregon**, Baseburg Ore., August 12; **Northwestern Section**, Owyhee Hotel, Boise, Idaho, September 11-13; **Southwestern Section**, Hotel Del Coronado, Coronado, Calif., September 18-21; **Western Section**, Biltmore Hotel, Oklahoma City, Okla., September 25-27; **Eastern Section**, Warwick Hotel, Philadelphia, Pa., October 9-11; **Southern Section**, Grove Park Inn, Asheville, N. C., October 16-18.

National Assn. of Lighting Maintenance Contractors—National conference, Las Vegas, Nev., August 21-23.

Western Electronic Show and Convention—Cow Place, San Francisco, Calif., August 22-25.

American Home Lighting Fixture Month—Sponsored by the American Home Lighting Institute, Chicago, Ill., September 1-30.

Rocky Mountain Electrical League—Fall Convention, Jackson Lake Lodge, Moran, Wyoming, September 10-13.

Industrial Electronics Symposium—Bradford Hotel, Boston, Mass., September 20-21.

Illuminating Engineering Society—National Technical Conference. Chase Park Plaza Hotel, St. Louis, Mo., September 24-29.

Industrial Building Exposition & Congress — New York Coliseum, New York, N. Y., September 25-28.

Third Virginia Biennial State-Wide Industrial Exposition—Victory Stadium, Roanoke, Va., September 27-30.

Florida Association of Electrical Contractors—Annual conference, Fort Harrison Hotel, Clearwater, Fla., September 29, 30—October 1.

Lighting Progress Exposition—Sponsored by the Electric League of Southern California, Hollywood Palladium, Los Angeles, Calif., October 3-5.

International Association of Electrical Leagues—25th Annual Conference, President Hotel, Atlantic City, N. J., October 4-6.

Western Building Industries Exposition—Great Western Exhibit Center, Los Angeles, Calif., October 7-10.

17th Annual National Electronics Conference — International Amphitheatre, Chicago, Ill., October 9-11.

National Electrical Contractors Association—Annual convention, Washington, D. C., October 9-14.

National Electrical Manufacturers Assn.—Annual meeting, Traymore Hotel, Atlantic City, N. J., November 13-17.

Sixth National Electrical Industries Show — New York Coliseum, New York, N. Y., March 11-14, 1962.

Electrical Apparatus Service Association—Convention, Conrad-Hilton Hotel, Chicago, Ill., June 3-7.

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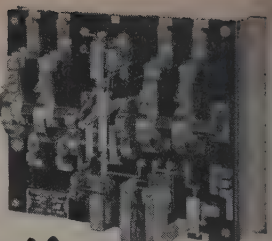

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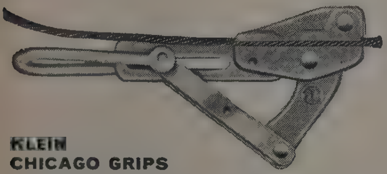

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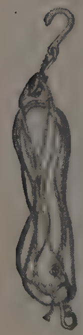

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Edwin L. Wiegand Co., Pittsburgh, Pa.—Bruce A. Fleming, executive vice president.

General Electric Co., Schenectady, N.Y.—Gene E. Lewis, manager of marketing and engineering, High Voltage Specialty Transformer Section, Holyoke, Mass.

Thomas Industries, Inc., Louisville, Ky.—John G. Beam, president.

Philadelphia Electrical and Mfg. Co., Philadelphia, Pa.—Robert B. Mugridge, general sales manager.

The Stanley Works, New Britain, Conn.—Edward M. Haines, vice president of engineering; William F. Oswalt, executive vice president.

Consolidated Electric Lamp Co., Lynn, Mass.—James A. Marsh, president; John P. Marsh, vice president and general manager.

DuKane Corp., St. Charles, Ill.—Kenneth E. Knudtzon, sales promotion manager, Commercial Sound Div.; J. McWilliams Stone, Jr., executive vice president.

Hubbard and Co., Pittsburgh, Pa.—Matt Anderson, chief industrial engineer, Hapco Div.

Electric Machinery Mfg. Co., Minneapolis, Minn.—Robert J. Mullenbach, general manager, Control Div.

Anaconda Wire and Cable Co., Hastings-on-Hudson, N.Y. — Rolland Jay Westcott, plant engineer, Hastings Mill.

Edwards Co., Inc., Norwalk, Conn.—Edward R. Flannery, supervisor of production control; Donald C. Plimpton, manager of Pittsfield, Maine, plant.

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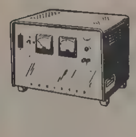

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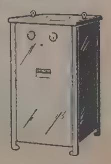

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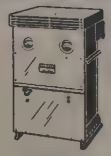

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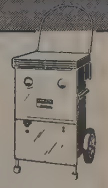

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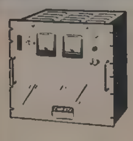

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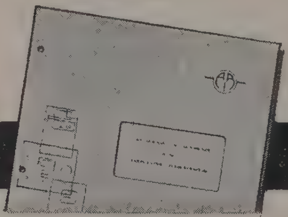

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Kenneth R. Geist, general manager of newly formed Special Products Dept.

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Westinghouse Electric Corp., Hampton, S.C.—David Hodowanetz, sales manager, Insulating Materials Section, Micarta Div.

Frink Corp., Brooklyn, N.Y.—G. H. Meyner, president.

Moloney Electric Co., St. Louis, Mo.—Donald E. Spackler, general manager, Switchgear Div.

Oak Manufacturing Co., Crystal Lake, Ill.—Dean C. Smith, vice president of manufacturing.

Silvray Lighting, Inc., Bound Brook, N.J.—John L. Kilpatrick, sales manager, Lamp and Process Coating Div.

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MIDDLE ATLANTIC

Rawlplug Co.: Patrick Delmonico, branch manager of new Syracuse, N.Y., office serving central and eastern New York state.

Pennsylvania Transformer Div., McGraw-Edison Co.: Daniel E. Winslow, Jr., manager of New York sales district.

SOUTH ATLANTIC

General Blower Co.: Folger H. Bigelow, Atlanta, Ga., sales representative; Charles Phillips, branch manager, Baltimore office.

Morrison Steel Products, Inc.: Edward Spencer, sales representatives for Virginia, Roly-Door and Roly-House Divisions; Jim Sangster Sales Agency, Charlotte, N.C., sales representative for North and South Carolina, Roly-Door Div.

Signalite, Inc.: Charles Lienau, Silver Springs, Md., representa-

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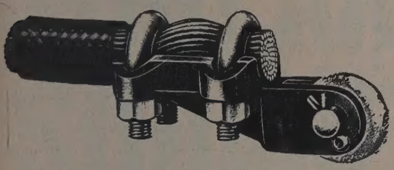

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Good Manufacturing Co., Inc.: C. Loren Benblow, illuminating and sales engineer in Chicago.

Wheatland Electric Products Co.: Joseph F. Devereau, Mid-South Sales Agency, representative in Arkansas, western Tennessee and northern Mississippi.

Slater Electric Co.: H. H. Seay Co., Columbus, Ohio, representative in Ohio, West Virginia and parts of Pennsylvania.

G&W Electric Specialty Co.: Gregory-Salisbury Co., representative in the additional states of Louisiana and Mississippi.

General Electric Co.: Charles S. Martin, midwestern sales manager, Insulating Materials Dept., with headquarters in Fort Wayne, Ind.

WEST CENTRAL

Owatonna Tool Co.: James L. Miller, district manager for Oklahoma and Arkansas, Tools & Equipment Div.

Progress Manufacturing Co.: Clay Hathcock, representative for northeast Texas and Oklahoma; Sam Humphrey, Southwest regional manager, headquartered in Dallas.

Westinghouse Electric Corp.: Forney Fuller & Associates, New Orleans, La., sales representative for Louisiana, Mississippi, Texas, southern Arkansas and western Tennessee areas, Sturtevant Div.

S & C Electric Co.: Johan A. Schwenke, sales engineer for northern half of Texas, with headquarters in Dallas.

WEST

General Electric Co.: Red Baurmeister, representative in new sales office in Burlingame, Calif., Silicone Products Dept.

Feedrail Corp.: Wm. Benndorf Co., representative in Arizona and New Mexico and El Paso, Texas, with offices in Phoenix and Albuquerque.

Edwards Co.: William H. Kresge, Pacific district manager.

Signalite, Inc.: Malcolm Ross, Los Angeles, representative in California, Arizona and Nevada.

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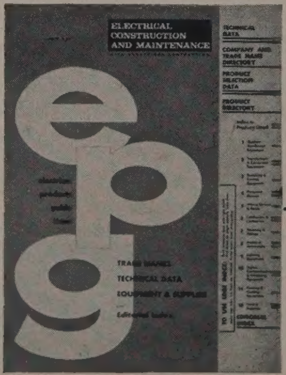


• These manufacturers advertised their products in the ELECTRICAL PRODUCTS GUIDE ISSUE

For more complete information, and application data on their lines, refer to the index of Advertisers in the ELECTRICAL PRODUCTS GUIDE . . . the 13th issue of ELECTRICAL CONSTRUCTION AND MAINTENANCE.

TO THOSE WHO ARE NOT USING SQUARE D QO CIRCUIT BREAKERS—

• If what we're going to say about the QO breaker was merely a matter of opinion (especially, *our* opinion), we wouldn't ask you to give this advertisement a reading. But since we're dealing with facts which have been proved by both demonstration and years of performance, we think you'll be ahead, in several ways, by giving it a complete going-over. Here are the facts—

QO is the finest breaker ever built. Other breakers have some of its design and performance features but none has all of them. Full "flash" protection; ambient compensation; quick-make, quick-break, and trip indication are only a few of the features which QO provides without added cost. Your Square D Field Engineer, with a simple demonstration kit, can prove that QO is the finest breaker ever built!

QO is the most complete breaker line. 15 through 100 amperes, 1, 2, and 3 pole breakers. Space-saving tandem breakers. 3φ Delta breakers. Water heater breakers. 150 and 200 ampere main breakers. Exactly the right breaker for every need without the added expense of special devices.

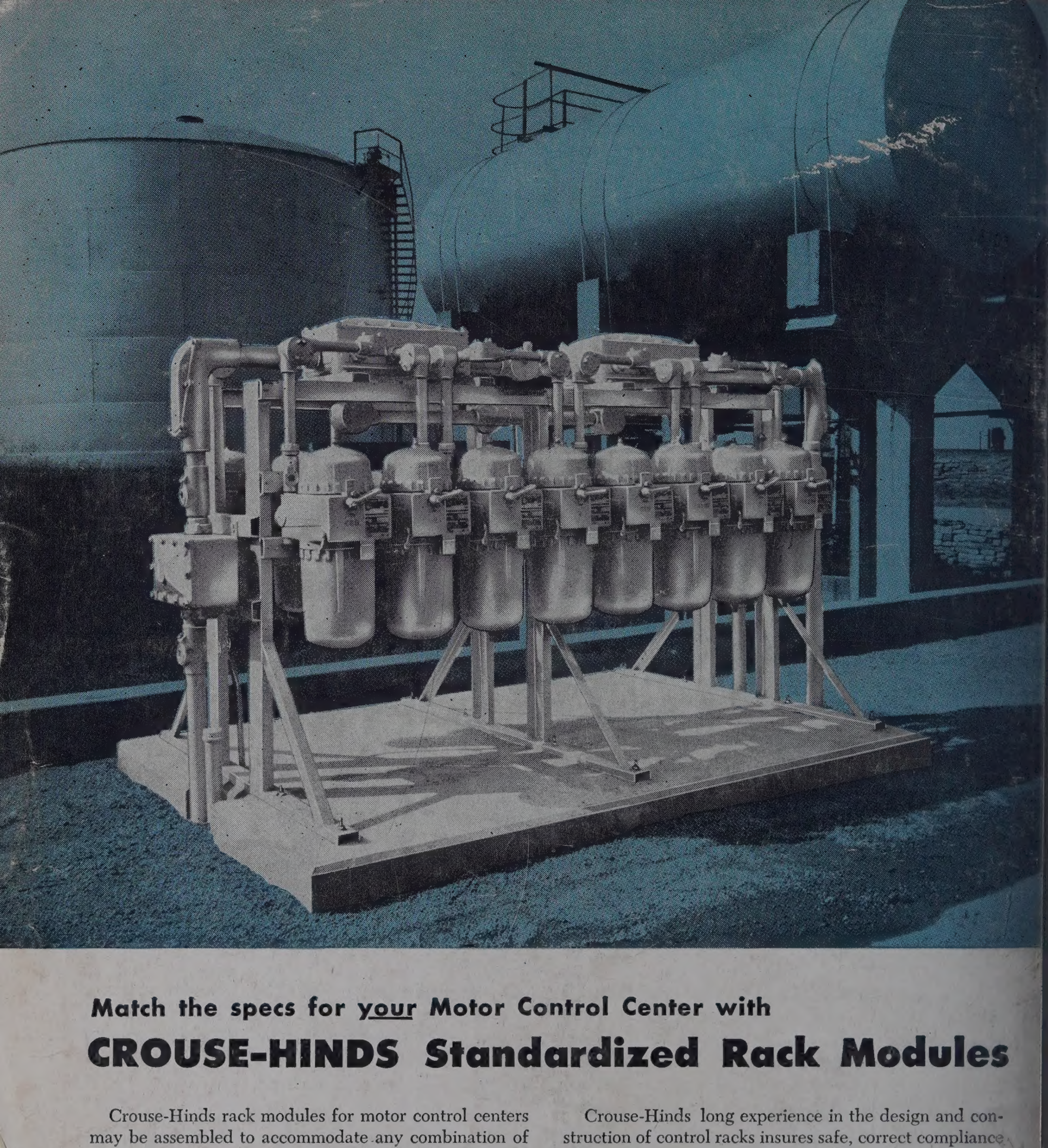
QO offers the most complete line of devices. 2 through 42 circuits. 1φ and 3φ, main lugs, main disconnects, split bus, indoor and outdoor enclosures. All devices, 100 amperes and up, are suitable for either copper or money-saving aluminum conductors. Couple these complete lines of breakers and devices and every requirement can be met exactly with off-the-shelf delivery of standard components.

QO offers the best method of providing non-interchangeability. By all odds, it's the easiest to use and inspect. Ask your Square D Field Engineer to show you how much simpler and faster it is than any system you've seen or tried.

This isn't the complete story. There are quite a few time-saving, space-saving and money-saving angles we haven't even mentioned. We hope we've hit enough of the highspots to convince you that it might be worthwhile to get all the facts. In which case, ask your Field Engineer, your Square D distributor, or write us direct—Square D Company, Mercer Road, Lexington, Kentucky.

SQUARE D COMPANY

wherever electricity is distributed and controlled



Match the specs for your Motor Control Center with

CROUSE-HINDS Standardized Rack Modules

Crouse-Hinds rack modules for motor control centers may be assembled to accommodate any combination of Crouse-Hinds motor starters, circuit breakers and accessory equipment. They may be specified to conform to any of the following requirements under the National Electrical Code:

- Class I, Divisions 1 and 2 (Type ERK)
- Class II, Divisions 1 and 2 (Type DRK)
- Weather Resistant, Raintight and Watertight (Type WRK)

Crouse-Hinds long experience in the design and construction of control racks insures safe, correct compliance with your specifications, from the simplest to the most complex.

For complete quotations on motor control racks designed to meet your specific needs, check your Crouse-Hinds Distributor, or contact the nearest Crouse-Hinds Office listed below.

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